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Evaluation of potential test environments for assessing the impact of Multi-Sensor Data Fusion on command and control operations in the Halifax class

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Evaluation of Potential Test Environments for Assessing the Impact of Multi-Sensor Data Fusion on Command and Control Operations in the HALIFAX Class Frigate

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On behalf of
DEPARTMENT OF NATIONAL DEFENCE

DCIEM Scientific Authority
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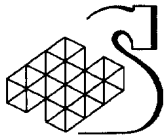
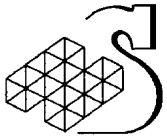


Abstract

This report reviews five training simulator facilities in the Canadian Navy for their suitability in conducting test and evaluation (T&E) in support of the COMDAT multi-sensor data fusion (MSDF) initiative. The facilities are the Operations Room Team Trainer (ORTT), the Naval Combat Operator Trainer (NCOT), the Combat Systems Training Centre (CSTC) and HALIFAX Class Ops Room alongside or at sea. A set of detailed capabilities for conducting T&E was developed under the four major categories of: Logistics, Experimental Control, Data Collection and Data Storage and Analysis. Each of the potential facilities was reviewed against these categories and the capabilities of each facility were then assessed for their suitability for conducting the expected range of T&E activities. It was concluded that the NCOT would be the most suitable facility for conducting T&E using single operators and small teams performing simple operational functions such as detecting and tracking radar contacts. For more complex functions in the Ops Room, including tasks involving interactions between complete warfare teams, interactions between warfare directors and the ORO, and between the ORO, CO and the entire Ops Room team, the ORTT represents the appropriate environment for conducting T&E activities. A range of scenarios exists for the ORTT and for NCOT, which may be adaptable for T&E purposes. Severe constraints on the availability of the ORTT (and possibly the NCOT) and the associated personnel infrastructure were noted, due to existing training demand from the Navy. It is recommended that a simple proof of concept trial for assessing the suitability NCOT for T&E be conducted as soon as possible.

Résumé

Le présent rapport porte sur la pertinence d'utiliser les cinq simulateurs d'entraînement de la Marine canadienne pour effectuer les essais et l'évaluation (E et É) de l'initiative de fusion de données des multicapteurs COMDAT (MSDF). Les installations comprennent le simulateur pour l'équipe de la salle des opérations (SESO), le simulateur d'opérations de combat naval (NCOT), le centre d'instruction des systèmes de combat (CSTC) et la salle des opérations de classe HALIFAX, à proximité ou en mer. Une série de capacités détaillées permettant d'effectuer les E et É a été identifiée en fonction des quatre grandes catégories que sont la logistique, le contrôle expérimental, la collecte des données et l'archivage et l'analyse des données. Chaque installation a été étudiée à la lumière de ces catégories et les capacités de chaque installation ont ensuite été évaluées en ce qui a trait à leur pertinence pour effectuer toute la gamme prévue des activités d'E et É. Il apparaît que le NCOT serait l'installation la plus appropriée pour effectuer les E et É tant avec des opérateurs seuls qu'avec des équipes restreintes pour les fonctions opérationnelles simples telles que la détection ou les poursuites de contacts radars. Pour les fonctions plus complexes de la salle des opérations, notamment les tâches nécessitant une interaction entre les équipes de guerre complètes, entre les directeurs de conduite de la guerre et l'ORO, ou entre l'ORO, le cmdt et l'ensemble de l'équipe de la salle des opérations, la SESO offre le meilleur environnement pour les activités d'E et É. La gamme de scénarios actuels utilisés pour la SESO et le NCOT peuvent être adaptés pour les E et É. Compte tenu des demandes d'instructions courantes de la Marine, la SESO (et peut-être également le NCOT), de même que le personnel qui y travaille, sont rarement disponibles. Il est recommandé de n'effectuer qu'un essai afin de confirmer la pertinence du NCOT pour les E et É dans les plus brefs délais.



Executive Summary

This report reviews five training simulator facilities in the Canadian Navy for their suitability in conducting test and evaluation (T&E) in support of the COMDAT multi-sensor data fusion (MSDF) initiative. The facilities are the Operations Room Team Trainer (ORTT), the Naval Combat Operator Trainer (NCOT), the Combat Systems Training Centre (CSTC) and HALIFAX Class Ops Room alongside or at sea. A set of detailed capabilities for conducting T&E was developed under the four major categories of: Logistics, Experimental Control, Data Collection and Data Storage and Analysis. Each of the potential facilities was reviewed against these categories and the results tabulated. The review took into account earlier work developing a framework for evaluating military information systems as well as JDL data fusion levels. This framework considers the need to conduct iterative evaluations of human performance during development in terms of part, whole, and team tasks at several levels of prototype design under mock up, test bed or simulator, and sea trial conditions. Existing Navy systems for collecting performance data were also reviewed. The capabilities of each facility were then assessed for their suitability for conducting the expected range of T&E activities.

It was concluded that the NCOT would be the most suitable facility for conducting T&E using single operators performing simple operational functions such as detecting and tracking radar contacts. While more limited in its simulation fidelity than ORTT, for repeated trials of simple tasks, the NCOT facility appears to be the most versatile to configure and the most economical to operate. NCOT allows the collection of T&E data for several operators performing the same task in parallel. NCOT also appears suitable for assessing performance of small teams of 2-4 individuals performing more complex, interacting functions. This assessment is based upon the expectation that the contractor responsible for NCOT will deliver software that supports this level of functionality within the next year.

For more complex functions in the Ops Room, including tasks involving interactions between complete warfare teams, interactions between warfare directors and the ORO, and between the ORO, CO and the entire Ops Room team, the ORTT represents an excellent environment for conducting T&E activities. A range of scenarios exists for the ORTT and for NCOT, which may be adaptable for T&E purposes.

Severe constraints on the availability of the ORTT (and possibly the NCOT) were noted, due to existing training demand from the Navy. Further, the necessary personnel infrastructure, as game players and controllers, in support the ORTT is high and is also constrained by personnel availability.

It is recommended that a simple proof of concept trial for assessing the suitability NCOT for T&E be conducted as soon as possible.

Sommaire

Le présent rapport porte sur la pertinence d'utiliser les cinq simulateurs d'entraînement de la Marine canadienne pour effectuer les essais et l'évaluation (E et É) de l'initiative de fusion de données des multicapteurs COMDAT (MSDF). Les installations comprennent le simulateur pour l'équipe de la salle des opérations (SESO), le simulateur d'opérations de combat naval (NCOT), le centre d'instruction des systèmes de combat (CSTC) et la salle des opérations de classe HALIFAX, à proximité ou en mer. Une série de capacités détaillées permettant d'effectuer les E et É a été identifiée en fonction des quatre grandes catégories que sont la logistique, le contrôle expérimental, la collecte des données et l'archivage et l'analyse des données. Chaque installation a été étudiée à la lumière de ces catégories et leurs capacités ont ensuite été tabulées. L'étude a tenu compte des travaux précédents pour développer un cadre d'évaluation des systèmes d'information militaires de même que des niveaux de fusion de données JDL. Le cadre tient compte de la nécessité d'effectuer des évaluations itératives des performances humaines pendant le développement en termes de parties, d'ensemble et de tâches d'équipe à divers niveaux de prototype sous maquette, banc d'essai ou simulateur, et conditions d'essais en mer. Les systèmes en service dans la Marine pour la collecte de données de performance ont également été étudiés. Les capacités de chaque installation ont ensuite été évaluées en ce qui a trait à leur pertinence pour effectuer toute la gamme prévue des activités d'E et É.

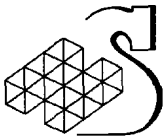
Le NCOT serait l'installation la plus appropriée pour effectuer les E et É tant avec des opérateurs seuls qu'avec des équipes restreintes pour les fonctions opérationnelles simples telles que la détection ou les poursuites de contacts radars. Bien qu'un peu plus limité en ce qui a trait à la fidélité de simulation que la SESO lors d'essais répétés de tâches simples, le NCOT est plus facile à configurer et moins coûteux à faire fonctionner. Il permet la collecte des données E et É pour divers opérateurs qui effectuent une même tâche en parallèle. Le NCOT convient également pour évaluer la performance de petites équipes de 2 à 4 personnes effectuant des tâches plus complexes avec des fonctions interactives. L'évaluation est conditionnelle au fait que l'entrepreneur responsable du NCOT doit fournir le logiciel soutenant ce niveau de fonctionnalité en deçà d'un an.

Pour les fonctions plus complexes de la salle des opérations, notamment les tâches nécessitant une interaction entre les équipes de guerre complètes, entre les directeurs de conduite de la guerre et l'ORO, ou entre l'ORO, le cmdt et l'ensemble de l'équipe de la salle des opérations, la SESO offre le meilleur environnement pour les activités d'E et É.

La gamme de scénarios actuels utilisés pour la SESO et le NCOT peuvent être adaptés pour les E et É.

Compte tenu des demandes d'instructions courantes de la Marine, la SESO (et peut-être également le NCOT), sont rarement disponibles. De plus, le personnel affecté à la SESO (techniciens et contrôleurs notamment) n'est pas toujours disponible.

Il est recommandé de n'effectuer qu'un essai afin de confirmer la pertinence du NCOT pour les E et É dans les plus brefs délais.



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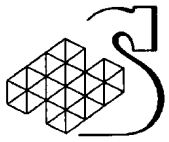

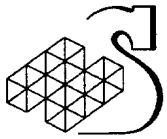

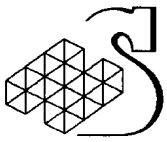

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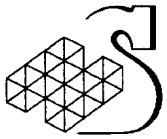
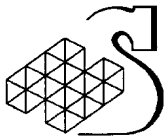


1. Introduction

This report addresses the requirement in the Statement of Work for DCIEM Contract No. W7711-7-7404-21, to review potential data collection environments and existing data capture tools and outputs for their ability to support the evaluation of the impact of future multi-sensor data fusion (MSDF) on command decision making.

This report is organised as follows. The first section describes the general methodology and is followed by a section containing detailed descriptions of five simulation facilities, the Operations Room Team Trainer (ORTT), the Naval Combat Operator Trainer (NCOT), the Combat Systems Training Centre (CSTC) and HALIFAX Class Ops Room (alongside or at sea)[1]. Systems developed by the Navy to capture and analyse combat systems data are also reviewed in this section. This followed by brief sections on availability of personnel for testing and availability of existing Navy measures of performance (MOPs). The report concludes with a discussion and analysis of the results and recommendations for next steps.

[1] During the course of gathering information for this project we learned that there were other test beds currently under development at DREV for prototyping and evaluating MSDF concepts in support of COMDAT. The Scientific Authority at DCIEM has indicated that evaluation of these would be out of scope for present purposes.



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2. Methodology

2.1 Background

The initial goal was to generate a list of potential ideal requirements to perform the full range of Test and Evaluation (T&E) functions in support of obtaining MOPs to assess the impact of MSDF. These requirements were derived from previous work by Human*systems* Incorporated (HSI®) in developing a generic framework for evaluation of C2 systems. Readers are directed to the report by Matthews, Webb and McCann, 1997 for full details of a generic framework of evaluation to assess C2 information systems, and to more specific work on the cognitive requirements of the Operations Room Officer (ORO) of a Canadian Patrol Frigate (CPF) (Matthews, Webb and Bryant, 1999). In addition, the limited available literature concerning C2 MOPs was consulted.

The general evaluation model is shown below,

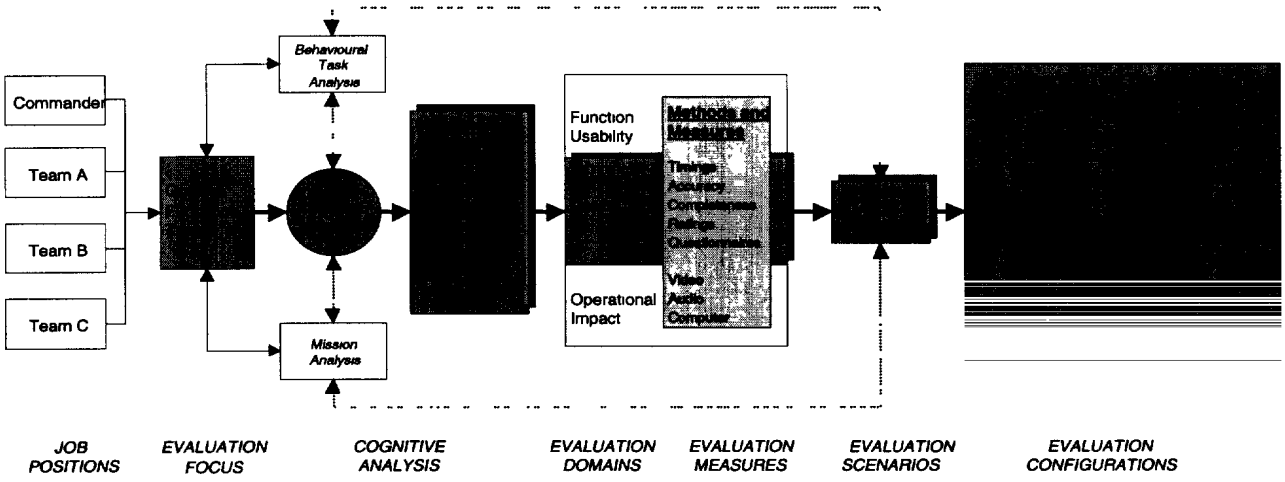


Figure 1: Conceptual Model for Test and Evaluation (from Matthews et al (1997)

2.2 Evaluation Domain

Using the above as an overall guide, it was believed that the overall focus of work for evaluating MSDF for COMDAT will primarily be in the *user fit* and *operational impact* domains. This is based on the expectation that the commercial developer of MSDF software will have conducted the T&E steps to ensure appropriate levels of function usability early in system and concept development, through assessment methodologies such as storyboarding and cognitive walkthroughs. Since the goal of the present work is on developing MOPs that are tied to the actual performance of operational tasks, the primary focus of the present analysis will be on configuration stages two and three as outlined below in Figure 2.

It should be noted that the test beds under development at DREV may be a suitable environment for conducting early assessments and proof of concept for MSDF prototype displays and functionality. These test beds may also evolve into systems that will accommodate some of the

requirements for stage two assessment. Cross validation of data derived from these different facilities should be a priority.

2.3 Evaluation Configuration

Three major types of configuration have been identified, as illustrated below.

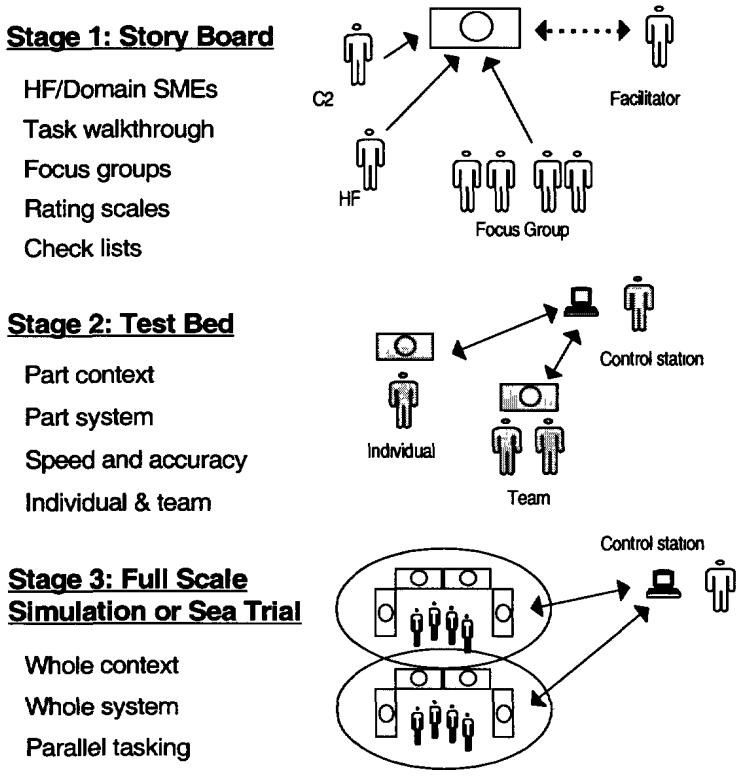
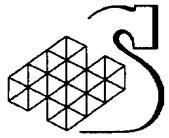


Figure 2: Three Evaluation Configurations

It is expected that the present T&E objectives will require a range of configurations from a simple test bed, through more complex test beds up to a full scale simulation or sea trial. The full scale simulation, as described below, would appear to be the primary candidate for evaluating the impact of MSDF at the levels of the warfare directors and above.

> *"The primary purpose of this configuration is to determine if the system will deliver acceptable operational performance under operational conditions. This will involve the achievement of more complex system functions and sub-goals at the whole system level, with fully trained users, and with the system in its final configuration and layout. This also implies the presence of concurrent and multiple tasks at the individual, team and crew level. Evaluation within this configuration should include not only the hardware and software components of the system but also training packages, layout and organisational structure."* Matthews et al (1997).

Although the original report placed the full-scale simulator and field trial environments in the same category, for present purposes it may be better to distinguish between the particular T&E



characteristics of each. As shall be shown later, the ORTT, CSTC and Ops Rooms alongside might all be considered to be examples of a high fidelity, full scale simulation, the NCOT represents a highly advanced level test bed and the Ops Room ship-at-sea represents the unique environment of a sea trial.

2.4 Fidelity

In considering the requirements for fidelity, we were guided by the following recommendations in Matthews et al (1997) concerning the various test bed environments.

> *"Potential levels of fidelity and completeness within this stage range from rudimentary to a full-scale prototype. At one end of the range, there are tasks and sub-tasks that require the interaction between one operator and a single console. At the simplest level, this could simply be a single screen, depicting a system state to which the user has to respond with limited options. At the other end of the range, the system software has the capability of generating dynamic events, sequences of events and a range of operator input functions. In terms of physical configuration, elements such as workstation, console and floor layout can be considered in the context of a command post or operations centre, vehicle, team or other operational configuration.*
>
> *Relevant levels of fidelity would include not only the appearance and dynamics of the software and hardware, but also the degree of realism with respect to the overall operational context in terms of volume and complexity of information, shift duration, lighting and other environmental conditions, and team operations."*

Thus, there is no single requirement for fidelity. Instead, it will vary depending upon the complexity of the operational function under scrutiny.

2.5 Scenarios

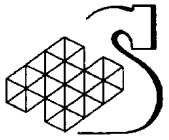
A final point of guidance, drawn from Matthews et al (1997) was the need to identify scenario elements that should be consistently applied across the range of T&E environments, recognising that the degree of sophistication in implementing these increases across the three evaluation stages. While this consistency was initially discussed in the context of the progressive evaluation of new systems, the general principle of having standard, validated tasks that can be accurately specified and benchmarked using statistically appropriate sample sizes, applies equally to the need of evaluating the potential impacts of MSDF against existing human-systems performance.

2.6 Criteria for evaluating the test environments

2.6.1 T&E Measurement approaches

Based upon above, it is anticipated that there will need to be at least five different T&E paradigms, as follows:

- Individuals doing part tasks, tasks and task strings in isolation (possibly using multiple subjects to collect data in parallel)
- A small team of subjects (e.g. a warfare area) performing mission-like tasks with interaction between team members
- Team interacting with each other



- ORO and warfare directors performing mission tasks.
- The entire Ops Room team performing small and large scale mission scenarios

Hence the particular test environments will need to accommodate this range of approaches.

2.6.2 Anticipated T&E Measures

Evaluation measures are expected to include: performance speed and accuracy in completing scenario-based sub-tasks, tasks and task strings; error patterns; timeliness of actions; measures of situation awareness using probe and other techniques; decision quality and speed; measures of communication effectiveness, communication load and estimates of mental workload.

To achieve this will require capabilities for:

- Video and audio recording of users actions and communications
- Logging of ongoing system events,
- Capture of user responses to injected probe messages,
- Capture of keyboard, switch or track ball actions that signify the start and end of tasks.

Specific measures will include time and accuracy to complete mission goals and sub-goals, successful completion of critical tasks, individual and team ratings of workload and situation awareness, and measures of team co-ordination and effectiveness. At the levels of teams, evaluation will involve more complex scenarios that involve the successive completion of multiple tasks by several users interacting as a team. Measures will include communication effectiveness and patterns, assessment of team situation awareness and evaluation of team co-ordination.

For more details of the general requirements for analysing the required logistical support for T&E MOP data collection, the reader is referred to Annex A of Matthews et al (1997) which describes the range of measures required. For present purposes, MOPs relevant to test beds and field trials have been extracted from this and are shown in Annex A.

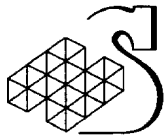
2.6.3 Analysis of requirements

Taking into account the measurement approaches and anticipated measures, four major categories of requirements were identified as follows. Each of these was then broken down into more detailed requirements, as outlined later in this section.

1. Logistics
2. Experimental Set-up and Control
3. Data Collection
4. Data Storage and Analysis

These detailed requirements were then used to provide a common basis for describing and evaluating each potential test environment.

There was considerable discussion concerning the development and use of criteria for evaluating the different environments and whether a formal quantitative approach for comparing candidate T&E environments should be adopted. Such an approach might involve generating a score for each item in the requirements list and then aggregating the scores using a weighted sum. In practice, this would mean that at the level of the individual requirement it would be necessary to establish precise criteria for each entry in the table (e.g. *"noise level in test facility is plus or minus 10 db from actual ship Ops Room*"). For other requirements it would be necessary to generate a rating scale for the degree



to which they met the T&E needs. Then, in order to obtain an overall estimate of capability of each environment, a weighting scheme might be devised to combine the individual requirement items to generate an single summary evaluation score that would allow at least a rank ordering of the alternatives.

In the end this approach was not pursued for a number of reasons. First, the question of interest is not which facility is *better overall* for meeting all of the T&E requirements, since there is no *single* T&E paradigm. For example, the fundamental needs to support T&E activities for individuals doing part tasks, tasks and task strings in isolation are clearly quite different from what is required for ORO and warfare directors performing mission tasks, or the entire Ops Room team performing small and large scale mission scenarios. Thus, it would be impossible to develop a weighting scheme that would have appropriate validity for all of these situations.

A second reason for not developing a quantitative evaluation metric for each T&E capability is that it would have involved a level of precision that was unnecessary. For most of the items in the requirements list, it is not necessary to know if the facility meets the need **optimally** but rather whether it **satisfies minimally, i.e. suffices.**

A third reason is that the level of effort required in developing a quantitative evaluation metric, given that it would be unproven and unvalidated, being simply based upon the opinions of the HSI® team. To create the necessary validity would require a level of effort that would inappropriately consume budgetary resources that are assigned elsewhere in the contract.

Therefore the approach chosen was to assess each environment in terms of what specific approaches and methodologies to T&E (i.e. areas indicated in section 2.6.1) would best be supported by the facility. In order to determine whether a particular test environment contained the range of required capabilities to conduct T&E, it was assessed against the following list of core requirements that would need to be fulfilled if the system were to be considered as a viable T&E environment.

These requirements were developed as a result of discussion among the HSI team members and based upon previous experience in developing and executing T&E activities within military contexts. Each of these items was considered to be essential for the successful conduct of T&E, with the possible exception of the item "*Capability for T&E personnel to create scenarios autonomously (with training)*". This could be considered to be a highly desirable requirement rather than essential, in that it has the potential to reduce the overhead in time and labour for scenario production. In essence, if the facility were not able to meet a single one of the following criteria (with the exception of the above), it would be considered to have serious limitations or be unusable as an appropriate T&E environment.

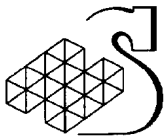
The core requirements are:

Logistics:

- Availability of the facility
- Appropriate Workstation Functionality (to the specific T&E paradigm)
- Flexible arrangement for workstation/controller combinations
- Capability to simulate the functions required for the team role or roles under analysis

Experimental Set-up and Control

- Capability to create T&E scenarios



- Capability for T&E personnel to create scenarios autonomously (with training)
- Capability to control T&E scenarios in real time (e.g. insert probes, messages)

Data Collection

- Capability to capture data to the required level of precision
- Capability to capture data reliably

Data storage and analysis

- Capability to capture the required volume of data
- Capability for reducing and analysing the data

For each of these items, more specific and detailed questions were developed in order to derive a better understanding of the capability of each environment. For example, under the general heading of "*Availability*", it was important to understand issues such as the booking process, the required lead time for booking, the ongoing usage pattern, whether the facility could be used exclusively for T&E and would need to be shared, and the general level of availability, e.g 24/7.

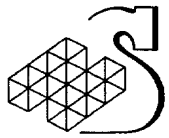
The result of this process was a comprehensive listing of questions and issues relating to the capabilities and these are shown in full in Annex B. This listing provided the basis for a common set of questions to be asked on the site visits when evaluating each of the facilities of interest.

2.6.4 Site Visits

Following development of the requirements and associated question items, a site visit was undertaken from February 18-22, 2001 to view each of the potential test environments (with the exception of the Ops Room at Sea). Four members of the HSI team took part in the visit and approximately 2-4 hours was spent at each site. This was supplemented with meetings with relevant SMEs to address the topic areas of the questionnaire in Annex B.

Wherever possible, documentation appropriate to the facility was obtained or requested for later delivery.

As part of the overall visit, HSI was provided with a lengthy briefing on existing data capture and analysis methods and an overview of sample exercise data.



3. Description of Facilities

As a result of the site visits, the review of available documentation, discussions and follow-up questions with local SMEs, answers to the detailed questions listed in Annex B were obtained. There were a few gaps in the answers where it has been impossible to obtain the required information. These answers and any relevant comments are shown in detail in Annex C for each of the facilities.

What follows in this section is a detailed description of each of the potential test environments based upon a distillation of the answers to the detailed questions. For convenience, each facility is described separately in a different sub-section, under the following common headings:

- Overall Description
- Simulation capability
- Scenario Development
- Real-time control and monitoring of scenarios
- Data recording
- Data replay and analysis
- Availability
- Support for scenario and test development
- Support for running T&E scenarios
- Support for data analysis
- Summary of advantages and disadvantages

It is suggested that having read, the summary descriptions of capabilities for each facility, the reader consuls Annex C for detailed information concerning any specific issue.

It should be noted that the issue of availability of personnel to act as T&E subjects is not discussed within the context of each facility separately, since the issues are essentially the same for all. A separate section deals with this.

3.1. ORTT

The descriptions below are largely quoted directly from descriptive documentation provided on the ORTT facility (ORTT SOM on CD), supplemented by information and photographs obtained during the site visit.

3.1.1. Overall description

The ORTT training complex consists of a large simulation/training system used for team training of HALIFAX Class operations personnel. The ORTT is an interactive, computer-based trainer capable of simulating two ownships, multiple other vehicles (air, surface, and sub-surface), and the weapons, sensors, and environmental effects needed to support Ops team training. The trainer (shown in Figure 3) consists of two functional HALIFAX Class Ops Room mock-ups (SimOps, labelled as CPF Cubicle in Figure 3), associated Bridge mock-ups, a Training Control and data capture facility, and a Brief/Debrief facility.

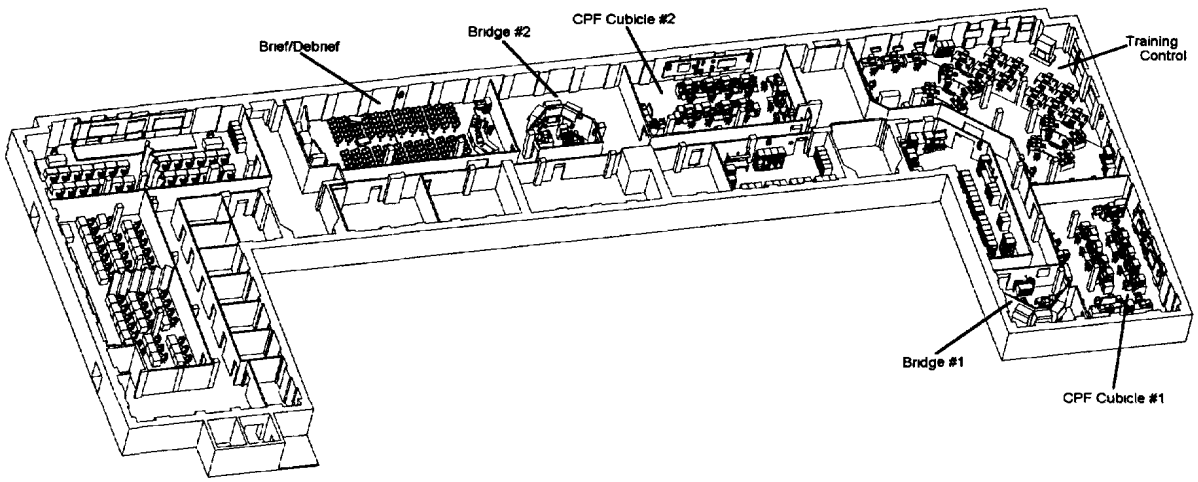


Figure 3: Diagram of ORTT

The *simulated bridge* is used primarily as a source to input data and receive communications from the simulated Ops Room. The bridge uses a large three-screen visual display to project the simulated ocean and air environments, and ship profiles as would be seen from a typical bridge. The display area is somewhat narrower in coverage than in reality. Various degrees of sea state and environmental conditions (e.g. fog) can be simulated. The displays provide a level of realism that is probably adequate for providing data for input to scenarios, if required. A workstation simulates the basic ship control capabilities and provides a communication link by headset/voice and data to the Ops Room.

Each *simulated Ops room* (SimOps) allows the Ops team members to receive training through the performance of their normal duties using equipment that accurately simulates the HALIFAX Class Ops Room equipment suite. Each room provides a training environment through the provision of operator consoles, control panels, and indicators, all located in accordance with the basic shipboard HALIFAX Class Ops Room and bridge layouts. The cubicle consoles, panels and indicators also possess the physical and functional fidelity associated with the HALIFAX Class Ops Room operator machine interfaces (OMIs). The two SimOps can be interactive, with both representing individual "ownships" within the same training exercise. The SimOps also contains versions of the usual stateboards, although the exact characteristics and locations are not identical to that of a typical HALIFAX Class Ops Room. Examples of a single ORTT workstation and a group of workstations are shown below. Note the high level of physical fidelity of the workstation itself.

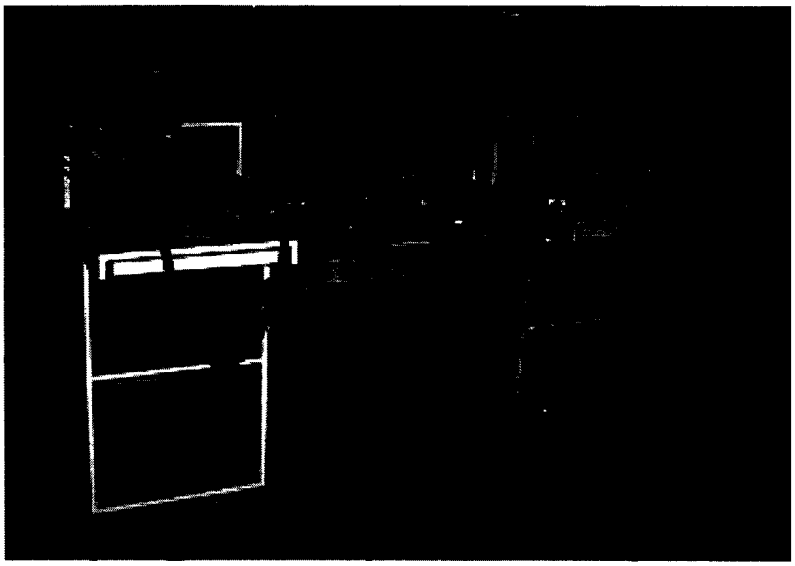
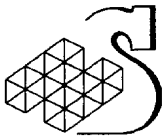


Figure 4: A single ORTT Workstation

Figure 5: ORTT Back Row - from position of CO

Each SimOps contains the following simulated but functional equipment suites:

a. Combat Operator Positions - Operator stations are provided for the Commanding Officer (CO), Operations Room Officer (ORO), Sensor Weapons Controller (SWC), Assistant Sensor Weapons Controller (ASWC), Electronic Warfare Supervisor (EWS), Shipboard Air Controller (SAC), two Radar Trackers (RT1 and RT2), Track Supervisor (TS), Sonar Control Supervisor (SCS), and two Naval Communicators (NAV COMMS). Each of these stations provides an operating environment within which the respective operators can perform their job tasks. As is the case in an actual HALIFAX Class Ops Room, the Operations Room Supervisor (ORS) has no dedicated



station in the SimOps, but the operating environment realistically represents the ORS's shipboard environment.

b. Officer of the Watch (OOW) Position - The OOW position provides the environment required for OOW operations.

c. Ship's Ops Room Indicators - Information normally provided by ship's bulkhead indicators is displayed in each ORTT Ops Room.

d. Communications - Internal and external communications for each team member within each cubicle facility are provided through a physically and functionally simulated Shipboard Integrated Communications System (SHINCOM), with personnel acting as role players to generate the required input messages to scenarios.

e. Command and Control System (CCS) - The ORTT supports the loading and execution of ship's CCS software. Execution of ship's CCS software provides for the highest possible level of system fidelity for all operators.

The SimOps facility does not contain workstations for CANEWS, CANTASS or GCCS, but simulated data from these sources are provided.

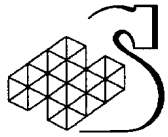
The *Training Control Facility* (TCF) provides the external interfaces to the SimOps cubicles for simulation and control and is physically separate from the SimOps. The TCF provides the instructor staff with the capability to set up training scenarios, control and monitor the progress of the training sessions, and subsequently debrief the trainee team. For the real time control of the training sessions, trained personnel are required to act as game players to move gamepieces and to act as communicators who provide appropriate input messages and respond to messages from the team in the SimOps. Training Control consists of the hardware and software and OMIs necessary to create a realistic Ops Room training environment. Training Control provides sensor, weapon and navigation subsystem simulation, and realistically models the impact that ownship motion, and the external ocean, meteorological and tactical environments have on ships' sensors.. Instructor stations are provided for the instructor staff to monitor and control the training exercises. Each Ops Room WS display can be monitored separately on a slave WS in the TCF. Training staff stations are provided for operators to participate in the exercise under the direction of the instructors or the staff manning the mock-ups.

These above capabilities are supported by the following:

- Instructor Stations are provided for the Tactics and Team Training Officer (TTTO), Anti-Surface Warfare Tactical Instructor (TAC ASuW), Anti-Air Warfare Tactical Instructor (TAC AAW), Anti-Submarine Warfare Tactical Instructor (TAC ASW), Tactical Air Control Instructor (TAC AIR), and the Command and Control Information System Tactical Instructor (TAC CCIS).

- Training Staff Stations are provided for personnel designated to assist the instructor complement. These stations include the Gamepiece Operators (GOs), Trainer Control Officer (TCO), Trainer Control Supervisor (TCS), Audio Visual Operator (AVO), and a Trainer Support Operator (TSO).

- Support Stations are provided for the CIO, Electronic Support Measures (ESM), Separate Tracking and Illuminating Radars (STIRs), Hull-Mounted Sonar (HMS), Sonobuoy Processing System (SPS), Canadian Towed Array Sonar System (CANTASS) and other ship outstation functions. Each of these support stations



provides the necessary system and voice stimuli to each cubicle's Combat System. The Support Stations include the Ownship Support Specialist (OSS), Fire Control Specialist (FCS), Acoustic Warfare Support Specialist (AWS), EW Support Specialist (EWS), and a Signals Operator (SigOp).

3.1.2. Simulation capability

The ORTT provides the capability for officers and Non-Commissioned Members (NCMs) of the HALIFAX Class Ops Room to learn, practise and enhance those skills that create an effective Combat Team in a simulated, multi-threat, multi-platform, time-stressed environment. The ORTT presents real-time dynamic simulations of tactical engagements to exercise the Combat Team in procedures, operations and the execution of tactics in a variety of situations that may occur during peace or wartime conditions.

The ORTT provides a realistic training environment by simulating Ops Room external interfaces wherein individual team members are permitted to perform their normal duties using equipment that reflect the functionality of the Halifax Class Ops Room suite of equipment. The ORTT provides the team with actual ship Combat System software and operator interfaces to create a high fidelity operating environment. Inputs to the Combat System support exercising the combat sub-teams (Anti-Air Warfare (AAW), Anti-Surface Warfare (ASuW), Anti-Submarine Warfare (ASW)) and the overall Command Team in the detect to engage sequence in multi-threat environments. Simulated natural and tactical environments are provided to support each HALIFAX Class sensor and weapon system in a synchronised and co-ordinated fashion.

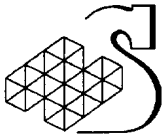
The ship operating environment is also enhanced by providing internal, external, and data link communications. Capabilities to support voice communications between the two ownships and other ships, aircraft, and submarines along with voice communication with ownship stations external to the Ops Room (flight deck, AN/SLQ-25 Torpedo Countermeasures Transmitting Set (NIXIE) winch, etc.) are provided.

The ORTT provides a natural environment in which either or both ownships operate. Training Control provides the capability to define the natural environment by setting the game time and specifying the gaming area and land masses, the meteorological and ocean environments, and the sea conditions that exist within the gaming area. Unlike the CSTC (as we shall see later) the ORTT provides the capability to degrade (under T&E control) sensor and communications data to reflect the kind of loss or ambiguity that might be expected in an actual operational context.

The **Natural Environment** includes the following features:

- Meteorological Environment - Used to establish the atmospheric conditions detectable by ownship and which affect ownship sensors.
- Geographical Environment - Used to define the gaming area, complete with landmass inputs and to orient ownship according to pre-designated geographic position.
- Oceanic Environment - Used to define the oceanic conditions that are detectable by ownship.
- Temporal Environment - Used to establish the timeline for the game.

The **tactical environment** provided by the ORTT includes air, surface and subsurface contact environment, the EW environment, the acoustic environment, and the communications environment. Tactical environment definition enables the user to define the air, surface, and



subsurface gamepieces with which ownship interacts. Gamepieces refer to all vehicles (air, surface, or sub-surface), deployed weapons (missiles, torpedoes, shells, mines, rockets), deployed sensors (sonobuoys, Expendable Bathythermograph (XBT) and Expendable Sound Velocimeter (XSV) probes, towed array sonar systems), and deployed countermeasures (chaff clouds and flares) in the gaming area. Gamepieces are fully independent and operational entities within the gaming area and possess physical characteristics to support their detection and identification by ownship sensors.

The **EW environment** refers to all non-communications electromagnetic spectrum emissions in the gaming area. Each ownship views the electronic emissions of the other ownship under the same conditions as the emissions of any other target. The elements that make up the EW environment are the vehicle borne electronic frequency sensors and weapons in addition to the target radar cross-sections and target radar aspect ratios associated with each type of target.

The **acoustic environment** refers to all vehicular, sensor, and weapon acoustic emissions in the gaming area. Each ownship will perceive the acoustics emissions of the other ownship when appropriate. The elements that make up the acoustic environment are the vehicle borne acoustic sensors and countermeasures in the gaming area in addition to the acoustic signatures associated with appropriate gamepieces.

The communications environment refers to all communications (electromagnetic) frequency activity in the gaming area. The elements that make up the communications environment are the vehicle borne communications systems including Low Frequency/Medium Frequency/High Frequency/Very High Frequency/Ultra High Frequency (LF/MF/HF/VHF/UHF) and Satellite Communications (SATCOM) systems. It also includes the tactical data-exchange radio link environment to support ownship Link-11 communications between reporting and participating units to produce a consolidated tactical Link-11 picture.

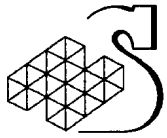
3.1.3. Scenario Development

The ORTT can be used in Preparation Mode to prepare a game prior to conducting training. In the preparation mode the scenario developer:

- Identifies gamepieces to be used in a scenario
- Uses the Gamepiece Editor to assign the required communication, sensor and countermeasure equipment to the gamepieces
- Uses the Gamepiece Editor to define the manoeuvring characteristics of the gamepieces
- Uses the Profile Editor to define natural environment characteristics
- Uses the Marking Editor to define call-signs and Link-11 Participating Units (PUs)
- Uses the Flight Plan Editor to define flight plans used for missile trajectories
- Uses the SAF Editor to place gamepieces to their initial positions at game start
- Uses the Game Editor to define ownship characteristics
- Specifies the required database when saving the game for use in future training sessions.

In general scenario definitions are developed using the tools provided above using a custom OMI.

The ORTT can also be used in Validation Mode to validate a game previously developed. The Validation mode allows the user to run all the elements of a game, excluding ownship, to ensure



that events occur as desired. The game may be started at any specified time in the scenario and may be run at any selected speed.

A number of sample scenarios were provided (e.g. "Clockwork Mouse") and these appear to have some of the necessary elements for the development of specific T&E requirements for sub-tasks, tasks and task strings.

3.1.4. Real-time control and monitoring of scenarios

The ORTT provides six tactical stations, used by tactical training instructors, to evaluate the trainees during simulated exercises. The user may select any one of the operations room console and monitor the trainee's actions in real-time. These stations allow the instructors to perform the following while monitoring the trainees:

- Determine whether mission success has been achieved
- Evaluate threat knowledge
- Assess the warfare engagement procedures
- Assess the trainees in the use of air control procedures and performances
- Compile the tactical picture
- Disseminate information relayed from the training cubicles
- Assess the execution of tactical and operational procedures
- Assess the employment of weapons, sensors, counter-measures and Command and Control System (CCS) uses

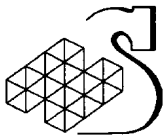
Real-time override capabilities exist for many functions to change parameters from those provided by the scenario database.

The controller may display a number of parameters from the SimOps workstation which is being controlled including:

- CCS Data
- CCS Tactical Picture
- Link-11
- Synthetic Environment
- Trainee Station
- Panels

The CCS Tactical Picture option provides for real-time monitoring and recording of the ownship tactical situation as held by the CCS Global Data Base (GDB). It allows the selective display of the tactical picture, as compiled by the CCS, with various filters, range scales and offsets. The tactical picture is presented inside a Tactical Situation Area (TSA) using standard Naval Tactical Data System (NTDS) symbols to display tracks. Note, however, that the CCS Tactical Picture application is passive in nature, so it is not possible to inject data in the system (such as creating, deleting or modifying tracks, or changing parameters).

The Link-11 Tactical Picture display allows training staff to display the Link-11 Synthetic Environment picture (air, surface or sub-surface). This capability allows the selection of various filters, range scales, offsets and graphic overlays that are used to optimise viewing of a selected



picture. This display capability is passive in that only the representative display of the source data is managed and manipulated.

Real-time monitoring and recording of events that occur on the CCS Serial Data Bus (SDB) network is also available. It has the same role as the History Recording (HR) module in CCS, except that all the events are displayed in tabular format. The following events are monitored and recorded:

- Quick Reaction (QR) data
- Threat rank data
- Weapons orders
- Operator entries and Quick-Action Button (QAB) selections
- CCS interface data
- Subsystem status
- System and console alarms
- Zippo status
- Tactical picture

For each cubicle of the SimOps the following type of events and environment can be monitored:

- Mission direction events
- Track management events
- Threat parameter events
- Electronic warfare events
- Weapons related events
- Surface operations events.
- Console Events - the operator's entry performed on a SimOps console.
- Status Events - monitoring of system status events of the selected console.

Faults may also be induced on all sensor, weapons and control systems.

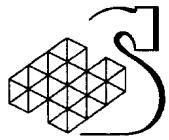
Controllers also have a capability to manage and modify tracks in the Link-11 simulation. The controller can also modify bearing, special point and Area of Probability (AOP) information by hooking the tracks and reselecting the QABs used to create them. The controller can also control and modify air tracks

The full range of internal and external voice communications can also be simulated and there is a control feature to simulate degraded transmission quality, by applying noise and/or reducing signal strength.

Scenarios may be stopped and continued from the point of interruption. T&E staff can insert markers into the stream of data to allow quick identification and fast forward to points of interest during data playback. There is also a generic slow motion, backup and fast forward capability.

3.1.5. CCS Data recording

The system provides the capability of recording all CCS data from every position in the SimOps on a running timebase. The timing precision of this is unknown at the present time.



The CCS Data window displays the data pertaining to the selected events and environments. The CCS Data window is limited to 200 rows. When the bottom row is reached, the first row is deleted and the new event is inserted at the bottom of the array. CCS Data is available for debriefing, so that events available for display in the CCS data window can be played back later in a game mode called Debrief mode.

This Data window provides information on the following:

- GAME TIME - Specifies the ORTT game time at which the event occurred.
- (EVENT ID) CCS EVENT NAME - Provides the identification and name of the event.
- DETAIL - Provides specific data on the event as available. The Greenwich Mean Time (GMT) time for each event is shown.

There is no capability at present for adding T&E system functions to capture data of interest that is not currently being recorded. Software to create such functionality would have to be developed under contract.

WS Screen/input devices

Within the TCF there is a capability of monitoring in real time the content of the display and some user actions. Manual actions such as key strokes, QAB selection and joystick movements are not themselves displayed remotely, but their outcomes are.

Communications

Communications at each position can be recorded and time stamped.

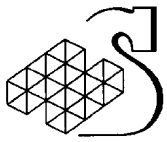
Video recording

Two video cameras provide a global view of all workstations with wide area coverage. The video data are recorded on separate video recorders; microphones pick up general noise and are recorded on a soundtrack. Additional video recording could be added (e.g. to monitor an operator), but the record would be independent of the existing video recording system and would need to be subsequently integrated with the scenario timebase.

3.1.6. Data replay and analysis

A group debrief facility is provided in auditorium with 3 large projections screens and loudspeakers for audio playback. In addition, data recorded during a training session may be replayed in the TCF. The system provides a debrief mode which allows replay of a simulation at one of four (0.5, 1, 2 or 5) play speeds for the debrief session of data that have been recorded. A Debrief Control is a tool available to the training staff to debrief trainees on completion of training sessions. It uses game data saved by the Game Monitoring functions. Three monitors, an audio system and a screen projector are available to debrief the trainees. Debrief session data is assembled using the Debrief Control panel. Information including hardware panels, CCS data, synthetic environment, Link-11, CCS tactical pictures, trainee consoles and audio recordings can be presented. Exercise data may also be replayed in the TCF.

Editing tools are available to assemble and compile an audio/video presentation from the recorded data. There is a capability to playback the data at slower or faster than normal speeds and to jump to specific points of interest that have been tagged either prior to, or during, the scenario execution.



3.1.7. Availability

The facility is currently used 16 hours day, 5 days week, through 2001/2002; 8 hours day are for training and 8 hours assigned to) for software development.

The ORTT must be booked by March-April for the following year's schedule. The scheduling process commences in March and is completed by September. Training is given first priority and blocks are assigned to CFNOS in, March, April, September and October; in addition, the facility is not available during vacations and CFNOS leave periods. Other ORTT priorities are Megaphase, Marlant OTTs (4x5days) and sub-team training The current usage is extensive for shakedown and building scenarios but it is expected that in the future L-M needs will be reduced. The facility is now 30% overbooked. The air warfare side is most congested right now.

While the equipment may be available during spare time in Megaphase, there would be no staff for running the trainers; (note these TCF staff are needed for scenarios logistics). However, the demands for staff would be reduced if only one warfare area would need to be simulated. It would be possible to fit in a three day pilot some time this year; longer blocks of time could be available next year. It is expected that NCOT will reduce some of the load or ORTT when NCOT fully comes on line because it provides a capability for training both basic equipment familiarisation skills and operational procedures.

Suitable data might be available from existing training courses to assess the feasibility of extracting and analysing relevant elements for MOP baselining.

3.1.8. Support for scenario and test development

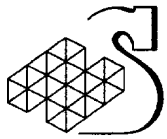
Excellent detailed documentation is available that describes the facility and how to build, run and replay scenarios. This material would provide a basic level of understanding for the T&E team on how to implement scenarios. However, the complexity of the task means that a more efficient approach will be to utilise the existing skilled support staff in order to develop scenarios and part tasks for MSDF assessment. Such staff are available but they already have significant ongoing commitments in building and running training scenarios.

It generally takes about one month to build a scenario from scratch. However, components of existing scenarios may be more readily implemented. Most of the training scenarios will be available within a year. Many of the gaming scenarios are available now; these are not full team, mission oriented scenarios, but represent part-tasks for single operators. Given available ORTT resources, training could be provided to test and evaluation personnel to develop the skills for real-time insertion of data into existing scenarios.

Depending upon other booking constraints, support staff could be made available to run the TCF side of operations in any future use of the facility for test and evaluation purposes. However, data analysis would have to be performed outside of training usage hours and may need to be subcontracted to L-M.

3.1.9. Support for running T&E scenarios

The ORTT infrastructure of hardware, software and personnel has the potential to provide all of the required support for the running of T&E scenarios. In particular, skilled personnel are available to run the software and to act as the necessary game players to provide the required dynamic real time inputs and responses to test participants' actions.



Adequate space is available in the TCF to allow T&E staff to monitor the scenario events and participants actions at each SimOps workstation.

The configuration of the system has limited flexibility but allows all four back row stations to play the same role (e.g. CO, ORO, SWC, ASWC) to permit multiple test participants doing the same pre-packaged tasks, although the upper limit for air functions would be three simultaneous workstations.

3.1.10. Support for data analysis

The TCF provides much of the required support for data reduction and analysis. However, this work is carried out currently under contract by L-M, hence there is not at present a toolsuite available for the T&E team to independently reduce and analyse the data. Further, the analysis must be conducted on-site. Provision of a tool-suite to permit off-site data reduction, analysis and presentation would significantly enhance the T&E capability of this simulator.

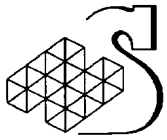
3.1.11. Summary of advantages and disadvantages

Advantages

- Comprehensive scenarios that encompass the full spectrum of Ops personnel functions and tasks.
- High degree of face validity in terms of equipment, layout and operational conditions.
- Available tools, expertise and knowledge to build scenarios.
- Scenarios run with a high degree of fidelity to actual operational environments
- Pre-packaged scenarios are under development and will be available shortly.
- Supporting players available to play the necessary background roles to feed data to scenarios, move game pieces etc.
- Capability to insert T&E real-time data into scenarios.
- Allows for multiple players in team tasks or multiple players (limited) on a single task.
- Real time logging of user actions, contents of screens, messages.
- Real time monitoring of user actions, screens, messages and space for observers to do some real time data capture in TCF.
- General audio and video recording of overall SimOps
- Two SimOps chambers available
- Excellent capability for data playback for individual and all workstations
- Potential capability to integrate MSDF functions into existing C2 software

Disadvantages

- Facility is in demand and access time is scarce. T&E would need to receive priority support from high levels of Command Authority in order to jump the queue.
- A large personnel infrastructure is required to develop and run scenarios.
- Analysis of scenario data will require sub-contracting some initial data reduction and compilation to L-M.



- Additional video and audio data would have to be manually integrated into existing recording capability.
- Reduced data may not be taken off-site for subsequent analysis.
- Any additional custom software modules for T&E purposes would need to be contracted to L-M.
- No recording of individual face to face conversations without additional microphones.

3.1.12. Conclusions

The ORTT provides all the technical requirements to run a range of scenarios in scope and complexity with a full or partial combat team. The support infrastructure provides the necessary capability to allow most of the anticipated T&E requirements to be accomplished. While there are some minor areas where additional capability might have been required (video and audio recording of individual team members), the major disadvantage in using the facility relates to its lack of availability, large infrastructure requirement and limited re-configuration ability.

With respect to availability, unless T&E activities associated with COMDAT are given priority over or can be combined with training functions, then there will be only limited access to the facility over the next two year span. The best that might be expected could be two blocks of 3-4 days each, according to current and anticipated bookings.

In providing this high level of simulation capability, the ORTT requires an infrastructure that is very comprehensive and labour intensive in support of scenario development and execution. Even if pre-packaged scenarios could be used for COMDAT T&E purposes all of the required personnel would still have to be brought together to support the execution of each test trial. The potential for conflicting demands on the services of these individuals will further constrain when T&E activities could be scheduled for the ORTT.

Therefore, taking into account the availability of the ORTT, its infrastructure and overhead requirements, our conclusion is that it should only be used for those COMDAT T&E purposes that will need comprehensive scenarios with multiple interacting combat team players. This might involve whole team functions at the warfare section level, or team tasks involving the CO, ORO and Warfare Directors.

We consider that it would be inappropriate use of both T&E and Navy limited resources to use the facility for part task and multiple task (as opposed mission oriented functions) T&E activities, in the light of the overall level of effort, planning and management required to set-up the required tasks and collect and analyse the data.

While actual requirements still have to be calculated, a reasonable estimate might be, at least, one week for preparation and pilot rehearsal and one week for data capture, each year, plus some software development support (more in early years). The schedule for T&E depends on COMDAT program but could be as early as Fall 2002. Preparatory development of data capture software and evaluation scenarios could start earlier.

3.2. NCOT

The information presented below is based on a discussion with a McDonald Dettweiler (MD) technical representative who has the local responsibility for the implementation and development

of NCOT, a CD containing screen dumps of the major NCOT functions and extracts from system documentation.

3.2.1. Overall Description

Examples of an NCOT workstation and a grouping of workstations are shown below. Note that the left screen in the work station (Figure 6) simulates the CCS screen and the right hand screen simulates the control panel of choice. The keyboard (etc) is only an approximate simulation of the "look and feel" of the actual CCS workstation.

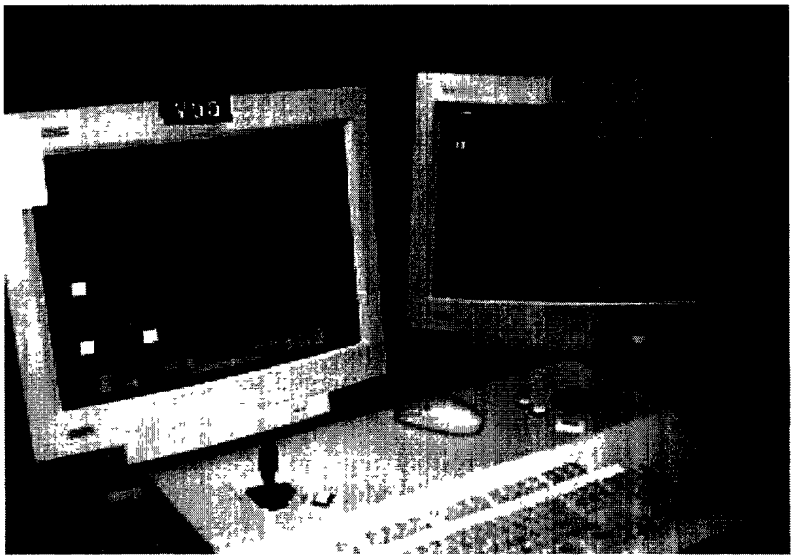


Figure 6: Sample NCOT Workstations simulating the RT1 position in VILLE DE QUEBEC

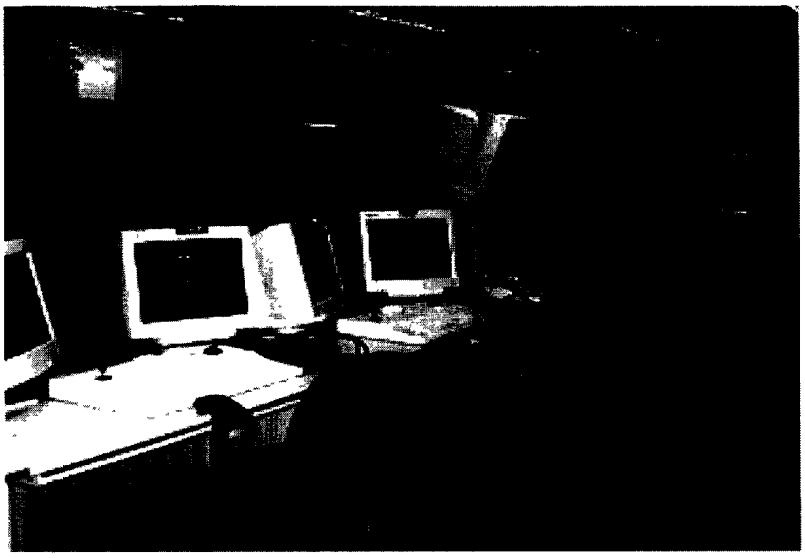


Figure 7: A grouping of NCOT Workstations

The NCOT has been designed to provide initial training and refresher training to students. The simulations provide a training environment for equipment operators to practice the integration of knowledge and skills to detect, analyse, classify, track, report, manage data, and prosecute contacts as would be required under an equivalent operational environment.

Multiple configurations are possible with NCOT. Workstations (W/Ss) can operate independently for individual action/reaction, or they can be grouped together so that students can participate in the same game. Although the NCOT flexibility enables it to be configured in ways different from an actual Ops Room, (e.g., assigning multiple Track Supervisor (TS) stations to the same ownship), the interaction of components in such a configuration is not predictable.

The NCOT facility at CFNOS is currently in the process of being implemented and its full range of functionality is not yet in place. There are 38 workstations (2 classrooms each with 16 operator positions, 1 instructor position and 2 developmental positions, which can be used as any operator position if desired. There is one briefing room with 2 big screens. A further nine workstations have been installed in TRINITY (Stadacona) and there are a further 48 workstations on the West Coast configured as four classrooms, but with no briefing room and local MD support.

The workstations are configured in two rows that, as presently laid out, loosely resemble the standard Ops Room format (see Figure 7). Some workstations have been grouped together as twos or fours to allow for computer-based training and other instructional purposes. The furniture and fittings of the facility have little in common with the ruggedised equipment environment of an Ops Room.

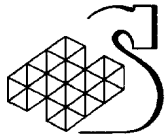
Each workstation has a keyboard, joystick, rollball and mouse for data entry/action purposes. This hardware is a standard commercial workstation product and differs physically from similar devices found in the Ops Room, although the layout is approximately the same. Hence the look and feel of input devices has somewhat lower fidelity to the actual operating environment.

Coloured CRT monitors can simulate any Ops Room CCS display, communication or other panel (e.g. weapons control). Thus, again there is lower fidelity in the look and feel compared with the Ops Room.

The capability to monitor what events and actions are occurring on an NCOT workstation is provided by instructor workstations alongside the trainee's workstation, as well as remote monitoring in a room next to the main test facility. The plan is to fully equip this adjacent room in order to enhance the remote monitoring/scenario interaction capability.

NCOT software runs on a variety of HP workstations using X Windows and Motif, VAPS, Gain, Windows 95 and Simphonics V+. This means that it has the potential to be run on workstations located outside the facility. However, there is currently no capability to transfer NCOT data from one NCOT to another, or between NCOT and other PCs. Part of this is a security concern and part is a hardware limitation. Transferability of the type desired for T&E purposes does not appear to be a priority for the Navy, and so probably will not be implemented in the near future, if ever. Hence, all T&E work would have to be done at one of the NCOT facilities.

NCOT software is currently based on CCS Version 4 which is a couple of versions behind what the Navy is currently using.. The plan eventually is to have it about 6 months behind what the ships have and plans are in place to update this to Version 6 within the next several months.



3.2.2. Simulation capability

The functionality of all of the combat team workstations can be simulated using MD proprietary SIMWARE, including CANEWS, CANTASS and HMS. There is no workstation specifically configured for bridge functions, but simulated information from the bridge or a helo can be fed into a scenario. Unlike the ORTT which uses identical hardware to an actual Ops Room, in NCOT the CCS and other operational systems displays, as well as input devices such as comm panels, are all simulated graphically on a CRT. There is no capability to simulate GCCS and the facility is not equipped with ancillary information sources such as stateboards, charts, TacPacs etc, although in principle there is ample space available to provide these in the future.

The full range of network audio comms found in an Ops Room can be simulated. Workstations can be flexibly configured to act as a single Ops Room workstation (e.g. the ASWC) or grouped together in which each workstation has the same role or functionality, i.e. there could be four or five workstations that are fed the same scenario and tasks, and test participants could all perform the same tasks in parallel. Further, workstations can be configured to allow small teams to function and interact.

SIMWARE provides the Simulation Trainer Control functionality, the Master Simulator, dynamic game control, game scenario definition, entity definition, and environment definition. SIMWARE also provides sensor modelling for HALIFAX and IROQUOIS class sensors, systems, Combat Control System (CCS) modelling and simulation, and the definition of Student Operator roles.

Conceptually, the system appears to be planned to accommodate functionality that would support the full range of Ops Room functions to be performed in a co-ordinated manner in mission oriented scenarios. At present, its capability seems to be focussed on providing training simulation for tasks and part tasks at the individual operator level, independent of interactions with the full combat team. This training is oriented towards equipment familiarisation and performing basic tasks.

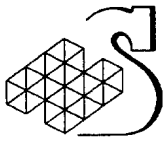
NOTE: At present, there is only software available to simulate the front row team; software to support the back row is scheduled for delivery on July 1/2001.

3.2.3. Scenario Development

It appears that all existing scenarios are being developed by MD off site from NCOT, and there is no Navy capability to do this at present. Hence, future T&E scenario requirements may have to be separately contracted to MD. However, it appears possible that T&E personnel with a senior Ops Room background could be trained by MD in a matter of days to develop specific T&E scenarios.

There has been some development of scenarios but, at present, these are somewhat limited in scope and comprise tasks and sub-tasks for individual combat team members rather than complete missions in which full combat teams interact with one another with real time support from game controllers and role players. These scenarios comprise basic training elements for the front row team only.

Limited documentation exists at present for existing scenarios or those under development. Currently, scenarios typically take a day or two to build, for example a two hour scenario centred on one combat team function, would take between an hour and half a day, if based on existing event database. It is the intention that in the final system that the Instructor Station (IS) will have the capability to develop new scenarios off-line, configure and reconfigure workstations in the classroom, and brief/debrief the scenario to students.



A Scenario Builder application runs independently of the main Instructor Station Tactical Display. This module provides a powerful development tool for the creation and editing of scenarios. The Landmass Generator is also a stand-alone module that provides the operator with the ability to create user-defined landmasses for use in scenarios. An Entity Library Editor (ELE) is available to developers for use in editing entity characteristics for permanent information changes to the entity class description.

The heart of the IS is the Tactical Display, which is the main user interface for the Instructor during the running of the game. The Tactical Display provides a view of the game area and control over each entity in a game to the Instructor. In addition, options on the Tactical Display menu allow the Instructor to modify certain environmental factors in a game.

There would also be an additional overhead associated with running T&E scenarios with respect to configuring each workstation for each test session. This would involve setting up the radars and other functions like fire control.

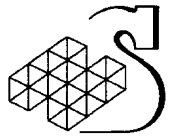
3.2.4. Real-time control and monitoring of scenarios

SIMWARE running on the Instructor Station provides the capability to control the game(s), control the vehicles/entities within the game, identify automatic student assessment parameters, change certain parameters during the game, etc.

The Instructor Station is made up of several software components that provide graphical interface for the Instructors as well as background calculations for the running of the scenarios.

The simulation also provides the following capabilities:

- Radar. Radar simulation is designed to calculate the target detectability based on effective range of a particular radar during each iteration of the radar calculations. When an entity or landmass point meets detection criteria, the appropriate information is passed through the internal network to the Graphicsware process running the Student Station for display. The Radar Sim includes an Identification Friend or Foe (IFF) component. This capability will be important for MSDF T&E.
- Sonar. Sonar simulation performs sonar acoustics simulation for towed array, hull mounted sonar, and sonobuoy processing systems emulations.
- Electronic Warfare (EW). EW simulation includes both electronic warfare (EW) components and passive and active countermeasures. The EW simulation has components for Canadian Electronic Warfare System (CANEWS), SRD-502, Reprogrammable Advanced Multimode Shipboard ECM System (RAMSES), and SHIELD processing.
- CCS. CCS simulation provides emulation of 10 HALIFAX Class control console operator roles: Assistant Sensor Weapons Controller (ASWC), Electronic Warfare Supervisor (EWS), Operations Room Officer (ORO), RT1, RT2, SAC, SCS, SPS, Sensor Weapons Controller (SWC), and CCS.
- Weapon Control System (WCS). WCS simulation contains components that provide simulation for Separate Tracking and Illumination Radar (STIR), Close In Weapon System (CIWS), Weapons Control Panel (WCP), and HARPOON, as well as the launching of acoustic countermeasures, flares, drones, and chaff.
- IFF. IFF simulation supports the functionality of IFF panels and supply responses to simulated IFF interrogation queries..



- Link-11. Link-11 Remote Control Panel (RCP) simulation is a part of the TS operator position. It will not simulate Link-11 transmission times, nor the functionality of the Net Control Station. Basic RCP controls and indicators allow the TS operator to perform the fundamental steps in order to enable receipt and transmission of Link-11 messages from his/her ownship.
- Aircraft Control Panel. Aircraft Control Panel simulation provides trainer-specific capabilities which enable students and instructors to control the assets of HALIFAX Class entities once they are launched. It enables control of course, speed, altitude and launching of sonobuoys, missiles and torpedoes.
- Radiation Control Monitor (RCM). RCM simulation provides support for the RCM panel and its associated controls by passing messages to the appropriate station.
- TACAN. The TACAN simulation provides homing beacons for the air assets of ownship. This is simulated by passing messages to the appropriate stations.

Each student role simulation is associated with a particular Ops Room function selected by the instructor. All sensor-based simulation is concerned with the detectability of each entity that is defined in the scenario. It must evaluate the position of each entity with respect to ownship at regular intervals. The position-keeping engine for the game updates the position of each entity once per second. Entities move according to motion characteristics defined in the scenario, but also respond to instructor ordered changes in course, speed, altitude or depth. When any of these are modified, the actual motion will change according to its characteristics defined in the entity library. The motion of entities can be paused and resumed by the instructor.

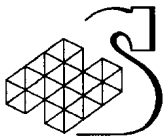
The instructor may control and vary the environmental conditions of the game. Each of the environmental conditions effect student role simulations in a variety of ways:

- Sea State - Sea State effects the radar clutter levels of radar simulations and the ambient noise level for passive sonar simulations.
- Wind - Wind direction and speed effects the motion of entities in the position-keeping engine of the game.
- Atmospheric Refractivity - The type of atmospheric environment effects the radar horizon for radar and EW simulations.
- Distant Shipping Noise - Omni directional distant shipping noise effects the propagation loss curves for passive sonar simulations.
- Ocean Model - Ocean model defines different sets of propagation loss curves for passive and active sonar simulations.
- Clouds - radar video and detectability of targets

3.2.4.1. General Communications capability

Voice over

As a student or instructor speaks into the microphone, the voice digitized and broadcast to all other stations. Each station in the trainer can receive all voice communications but they are locally filtered based on rules specified in the communications plan for the scenario. The instructor prior to starting a game assigns the communications plan to the station. When stations are not included into an active game, they are provided with a default communications plan.

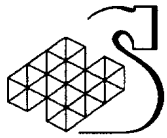


Communications Plan

A communication plan defines fast action buttons on the communications terminal. Each fast action button has an on/off state and is defined as making a connection to an ownship intercom or radio. If a radio is defined, then the attributes of the radio must also be specified. Intercom voice communications are within ownship and radio voice communications between ships. Intercom voice communication is full duplex and radio voice communication is half-duplex. Within a game, if multiple stations assigned to the same ownship select the same intercom, then voice activity is heard by all connected. Also, if stations assigned to different ownships select the same radio, then voice activity is heard only if the ships are within radio range of each other.

Point-To-Point Communications

Each station can call any other station in the trainer. When the station is a part of a game, each station in the game can call only those stations that are a part of the same game and assigned to the same ownship. Experienced personnel may be required to provide appropriate communications input and responses appropriate to the scenario context. In the case of more simple, routine scenarios where communications are more predictable, a less experienced person may provide the necessary communications by following a script.



Personal Address System

The instructor is provided with a public address system. The following PA capabilities are allowed:

- Address all stations in the trainer
- Address all stations in the classroom
- Address all stations grouped into a single game within a classroom
- Address all stations assigned to the same ownship within a game

Jamming Radios

If a radio is defined in the communications plans used within a game the instructor can jam it. 'Jamming' a radio consists of the instructor selecting a radio jamming WAV file from a set list and applying it to one of the radios in the game. The instructor also selects the volume of the WAV file. Jamming a radio can be established at the beginning of the game or as the game progresses

3.2.4.2. Student Monitoring Tools

The instructors set of tools includes software that allows for monitoring the voice communications of the students in the classroom. Also, each individual student desktop activity may be monitored using a separate software package.

Communications

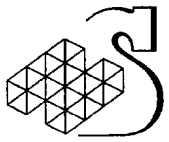
The GPRT audio monitoring software uses the classroom configuration settings to read and the communications plans assigned to each station in the classroom. It builds a list of all possible point-to-point connections that can be made by the instructor. It also builds a list of all the possible public address options available to the instructor. As the game progresses and each student selects/deselects intercoms and radios for voice communications, this software keeps an up-to-date list of all active selections by students. The instructor may choose any active intercom, radio or point-to-point call for monitoring. The instructors' presence is not noticeable to the students unless the instructor depresses the microphone to speak. This allows the instructor to monitor students for appropriate voice communications and intervene only when deemed necessary.

Workstation monitoring

The GPRT desktop monitoring software allows the instructor to choose any station in the classroom and bring the desktop activity of that station to the desktop of the instructor. This type of monitoring can be done inside or outside the context of the game and only requires that the student login at the station to be complete. The instructor also has the ability to use the mouse at the instructor station to point to areas of the student desktop. In this case, both the instructor and student see the mouse as it moves.

More generally NCOT provides the following functionality:

- Scenario events may be controlled either through pre-programmed scenario scripts and associated underlying databases or by real-time dynamic input from game controllers. Depending upon the degree of complexity and or uncertainty of the scenario, controllers may be either personnel with the appropriate military knowledge, or for simple scenarios, non-military personnel who are trained to follow a script.



- Audio and text messages that are not already scripted may be sent to any workstation from a sim control workstation. The GPRT provides the ability to play sounds in the headset of each station while a game is running. It also provides for regulated voice communications between stations along with a public address system for the instructor. Radios that are defined in the game may be jammed at the discretion of the instructor.
- Any sim workstation can be monitored on a second workstation, including screen content, pointers, cursors, actions on simulated input keypads
- Printouts can be taken of screen snapshots

A scenario may be frozen at any point in time, with all screen display information intact, to accommodate some aspect of T&E assessment. The scenario may then be re-started and will pick up from the point at which it was halted.

At present there is no separate simulation suite that corresponds to the TCF in the ORTT, although an adjacent room is available for this purpose should it be needed.

3.2.4.3. Logistical support for running scenarios

There is limited personnel support for running scenarios at present. The MD technical representative is the only person with the current skills to build, run and control scenarios from the instructor position. One Navy representative indicated that he thought that T&E activities should be as self-sufficient as possible and drawing minimally on Navy resources. This may present some difficulties for more complex scenarios involving the CO, ORO and warfare directors, as players would be needed to play the roles of lower level team members in order to provide the required data. Similarly, one would need players to provide data and communication from the usual sources of outside of the Ops Room.

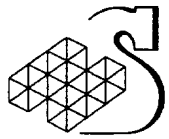
3.2.5. Data recording

All keystrokes, screen navigation, actions on comm buttons and panels, contents of CCS display and network voice comms can be captured in software along a running timebase. The temporal resolution was stated to be less than 1 second but this seems to be an estimate rather than a known capability. Non-network voice comms would require additional individual microphones and standalone recorders. These would not be co-ordinated on the timeline with the data collected by software and hence would need to be integrated after the fact. There is no built-in video recording capability at present, however, we were advised that there is ongoing development of the recording capability.

The capacity of the record capability is 2 gigabytes, but there is no experience yet to determine what this means in terms of events and time span.

The GPRT desktop record and playback software allows the instructor to record and group of stations together. This recording includes both the desktop and all voice communications and sounds associated with a station. The instructor can not only select stations used by students for recording, but also the station in use by the primary instructor. This allows for a complete review of all aspects of the game on playback.

When recording has been stopped, entries are made into a recorded data catalogue for the classroom. This catalog is organised by station and contains a description of each of the recording sessions along with the filenames that were created during recording. For playback, the instructor selects the desired station or group of stations, selects the appropriate catalogue entries and initiates



playback. Playback occurs on each station until either the playback completes or the instructor stops the playback.

3.2.6. Data replay and analysis

Data collected during the scenarios can be played back at real speed, or at 1/2, 2x, 4x, 8x or 16x regular speed. Data replay must always be started from the commencement of the scenario. Hence, if one were interested in a point 75 minutes into a scenario, one would fast forward at 16x speed to the 75 minute mark. If subsequently, one were to then want to go the 55 minute mark, the record would have to be rewound to the start and fast forward again implemented. The playback cannot be stopped without losing data from the displays.

There is no existing capability to analyse or reduce data; this would need to be developed by MD.

There is ongoing software development to enhance the data replay capability.

The software to provide replay is not yet in place and is expected for delivery on July 1. This will allow replay for one operator position only plus ground truth. More comprehensive playback capability has been requested by the Navy, but according to one estimate, implementation is about one year away.

3.2.7. Availability

It is expected that once fully functional, NCOT will have similar demands for access as the ORTT. Although at present Navy demand is currently lower than for ORTT but this is offset by a significant usage by MD for system development. It is likely that the facility will offload some of the part-task training from the ORTT in areas such as equipment familiarisation and training in basic operator tasks and sub-team procedural training.

3.2.8. Support for scenario and test development

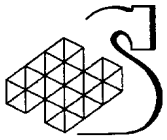
At present there is no infrastructure in place to provide this. All scenario development is carried out by the technical representative of MD at CFNOS, although, as we have indicated above, it may be possible to train an HSI® team member in this skill. In practice, this would mean that the T&E team would have to provide the scenario script in detail, possibly taking advantage of the existing database of gamepieces and events. It is possible that some the small-scale scenarios that have been created to date for computer based training may be of assistance in the creation of T&E tasks and part-tasks.

3.2.9. Support for running T&E Scenarios

At present there is no specific infrastructure in place to provide this. However, in principle similar staff support to that found in the ORTT as game controllers and players could be provided. Access to such support would have the same constraints as for the ORTT. The overall level of support required to run NCOT scenarios is significantly less than for the ORTT. In fact, one of the existing support personnel indicated that he could do it alone provided there were players available to provide external or outstation input.

3.2.10. Support for data analysis

Data captured during scenarios may be played back at normal, accelerated or slow speed. Special purpose software would need to be developed to automatically capture and reduce specific data of interest for T&E purposes. Special arrangement would need to be made to analyse data off site and



a specially configured workstation would be required locally to accomplish this. Further, negotiations with MD would be required to address commercial proprietary issues. At present there is no capability for reducing data and exporting it in a format that could be used by COTS analysis products (e.g. Excel, SPSS).

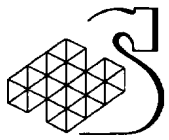
3.2.11. Summary of advantages and disadvantages

Advantages

- The potential exists to build comprehensive scenarios that encompass the full spectrum of individual Ops personnel functions and tasks.
- There is moderate face validity to the Ops Room in terms of equipment, layout to operational conditions.
- Available tools, expertise and knowledge to build scenarios.
- Pre-packaged scenarios are under development and will be available shortly mainly for single operator tasks.
- Capability to insert T&E real-time data into scenarios.
- A high level of flexibility in terms of configuring the T&E environment to allow for multiple players in small team tasks or multiple players on a single task.
- Could be readily configured to allow for a situation in which one controller on an adjacent workstation could control and interact with a number of workstations all playing the same role. Hence, there are personnel, time and cost savings over running single subjects in single roles.
- Real time logging of user actions, content of screens, messages.
- Real time monitoring of user actions, screens, messages.
- Capability for data playback for individual and all workstations (the latter in the future).
- Facility may be in less demand than the ORTT.
- Lower level of personnel infrastructure required to run scenarios, compared with ORTT.
- Potential capability to integrate MSDF functions into existing C2 software.

Disadvantages

- Currently the facility is in demand and access time is limited. T&E would need to receive priority support from high levels of Command in order to jump the queue.
- Analysis of scenario data will require sub-contracting some of the initial data reduction and compilation to MD.
- Look, feel and location of input devices somewhat dissimilar to Ops Room.
- Additional video and audio data would have to be manually integrated into existing recording capability.
- The development of software modules for T&E purposes would need to be contracted to MD and/or T&E staff would need to be trained.
- Existing scenarios are limited in scope.
- No recording of individual face to face conversations without additional microphones.



- Absence of stateboards and other auxiliary information sources.
- Absence of dedicated workstations for CANEWS, CANTASS, SPS and GCCS.
- No existing capability for back row team functions (expected in July 1/2001)
- No proven capability for supporting functions that involve teams, either at the warfare or Ops Room levels.
- No current Navy infrastructure for game players and scenario controllers.
- Limited capability to pause play and then continue.

3.2.12. Conclusions

NCOT provides much of the required technical capability to run a range of scenarios in scope and complexity with individual operators right now, or with small teams in the foreseeable future. There is one major reservation in considering using the facility for T&E purposes and this relates to the degree of sophistication and reliability in its current state of implementation. NCOT cannot yet be considered as a fully functional T&E environment with the same level of scenario development as the ORTT, nor is there the same level of accumulated experience in running and analysing scenarios. Scenarios are limited in scope, require MD support to run and are centred on single operators doing relatively simple tasks. Further, much of what we have learned of the capability and future potential is based upon information during a limited interaction with the MD technical representative and from system documentation. From the information received it seems possible the facility could potentially evolve into the same degree of functional sophistication as the ORTT. To date, much of that functionality remains to be developed and rigorously tested and evaluated.

Notwithstanding this reservation, one major advantage of NCOT over the ORTT is the flexibility in functional arrangement of the workstations to allow either individual players to play individual team roles (as in the ORTT) but also to allow multiple workstations to play a single role. Such a configuration represents an efficient approach to data collection for tasks and part tasks, which are limited in scope, but allow data to be accumulated in from multiple players in parallel. Further, there may be a much lower overhead than the ORTT for conducting T&E functions with single operators.

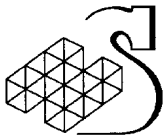
There are some minor issues concerning the need for additional capability (video and audio recording of individual team members, workstations for CANEWS, CANTASS, SPS).

With respect to availability, NCOT suffers from the similar demand to the ORTT. Although at present, it is primarily used for training individuals in system and function familiarisation using tasks and tasks strings, rather than full scenarios that involve interacting combat team members

The existing NCOT infrastructure that we have observed is largely a commercial function provided by MD in support of scenario development and execution. Any future software to support T&E requirements would need to be developed under contract by MD. At present, there appears to be very limited infrastructure in place in the form of game controllers and players to run complete mission scenarios.

Existing scenarios are limited to single operators doing simple tasks for basic training. It is not known the extent to which scenarios already developed, or under development, for the ORTT can be ported to the NCOT environment.

Our overall assessment of the NCOT facility is that it will make a highly suitable environment for collecting MOPs at the sub-task, task and task string levels for single positions (front row now,



back row later this year). It appear to have the capability for T&E scenarios involving individual warfare teams, in group sizes from two to four players. It provides the required capabilities for building test scenarios, controlling their execution and collecting data. It offers a higher degree of flexibility than the ORTT to configure the environment to maximise data collection on individual tasks.

There is insufficient evidence available at the moment to assess how suitable the facility would be for the execution of full scenarios with complete Ops Room teams. We do have some concerns that remain to be resolved over the reliability of the system and the fact that it has not been utilised sufficiently to the point where we can be confident that robust data can be collected and delivered for analysis. A final concern is that all T&E work would be highly dependent upon the commercial technical support that would need to be provided by MD. Although it appears that training could be provided to T&E personnel to allow them to build simple scenarios and run them independently of the Navy but with the assistance of MD.

3.3. CSTC

3.3.1. Overall Description

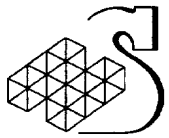
The CSTC comprises a suite of rooms to support the training and evaluation of Navy personnel in an environment that has high face validity to the Ops Room in a HALIFAX Class frigate. The physical hardware and CCS system software are identical to that found on a frigate and the layout closely approximates reality. The technical infrastructure that supports the simulate Ops Room is the same that is found on board the ship, and, hence has no specific in-built capability for T&E purposes. All displays are fed data in the same way that they would be on ship and all communications function in a similar manner to their ship counterparts. Data for scenarios may be fed to the system from recordings of real data collected on missions. Unlike the ORTT and NCOT, which have been designed from the ground up with new software and technology to support training and simulation requirements, the CSTC is essentially a land-based version of a HALIFAX Class Ops Room using the same operational equipment.

3.3.2. Simulation capability

The functionality of all of the combat team workstations can be simulated including CANEWS, CANTASS, HMS and SPS; no GCCS is available and simulated data can be fed from outside sources such as bridge, helo and Maritime Patrol Aircraft (MPA). The full range of network audio comms found in an Ops Room can be simulated. The system could be configured to allow simulation and data collection for up to three simultaneous players for any of the functions of the back row team. Lighting and noise levels are similar to those found on ship. The facility does not have the capability to degrade sensor data in a controllable manner to mimic actual conditions (e.g. as is found with the ORTT and NCOT).

3.3.3. Scenario Development

A number of scenarios are in existence to run in this facility. They could be used in whole or modified in part for T&E purposes.



3.3.4. Real-time control and monitoring of scenarios

The infrastructure provides a capability for manual input of all simulation events and hence both freeze and tracking probes could be injected by the T&E team. All communications required for the scenario must be input in real-time and cannot be pre-recorded. Text messages would be manually handled in a similar manner to the Ops Room. Scenarios can be run to a precise timeline but may also be stopped, backed up and re-run under manual control. T&E data that are conditional upon team members' responses could be input in real time. Experienced personnel are required to act as game controllers and players in complex scenarios. For simpler scenarios, personnel trained to follow a script would be adequate.

3.3.5. Data recording

There is no capability at present for audio or video recording, although there is a possibility of adding C-SAVRAS (see section 3.6.1) in the future. Neither individual keystrokes nor the content of the CCS can be recorded although adding C-SAVRAS would support the latter and also allow for recording of all net based communications. Data can be captured using the "bus-sniffer" which is described in section 3.5.1. Data recording is limited in scale such that for a full scenario with all possible information captured, only ten minutes of recording could be made. There is a trade off between the amount of information collected and the resulting length of data recorded. Data are not captured with associated time tags

3.3.6. Data replay and analysis

Data captured during scenarios would need to be played back on site. There is no existing capability for data reduction or export. Special software would be required to make use of the History Recording function were it to be implemented.

3.3.7. Availability

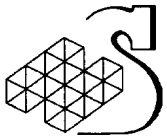
The CSTC is somewhat more available than the ORTT. It runs on an 8-hour shift 24/7 operation. LM uses it for eight hours per day and CFNOS for a further eight hours. At present there is very little available capacity. Booking arrangements and priorities are the same as for the ORTT.

The CSTC is currently being used primarily for technician training and software development, but is being used occasionally by the TTT staff for sub-team training, particularly where there is a requirement to use real as opposed to emulated/simulated equipment. An example is when training with CANEWS and SHIELD are required.

TTT still has the people to flash up and run the CSTC, but these are the same people who would run the ORTT. Thus, the more support required for T&E to run and amend CSTC scenarios, the more these needs would be competing with the ORTT which would probably have higher priority.

3.3.8. Support for scenario and test development

Navy support personnel could be made available to assist in this process. Some training could be provided to T&E staff to allow them to develop the necessary skills for modifying scenarios and hence allow for a more flexible approach to scenario development that is less constrained by the availability of Navy SMEs. Existing scenarios for the CSTC are not being updated, but there are many valid scenarios in the database



3.3.9. Support for running T&E Scenarios

Navy support personnel could be made available to assist in this process.

3.3.10. Support for data analysis

Navy support personnel could be made available to assist in this process.

3.3.11. Summary of advantages and disadvantages

Advantages

- Can simulate comprehensive scenarios that encompass the full spectrum of Ops team functions and tasks.
- High degree of face validity in terms of equipment and layout; the full range of Ops Room team functions can be simulated.
- Available tools, expertise and knowledge to build scenarios.
- Scenarios run with a high degree of fidelity to actual operational environments, however information (sensor data, communications) may not be able to be degraded to represent operational contexts.
- Complex scenarios can be created and a database of these is available.
- Supporting players available to play the necessary background roles to feed data to scenarios, move game pieces etc.
- Capability to insert T&E real-time data into scenarios.

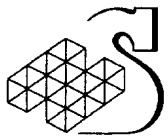
Disadvantages

- Facility is in demand and access time is scarce. T&E would need to receive priority to jump the queue.
- Large personnel infrastructure to develop and run scenarios.
- Additional video and audio data would have to be manually integrated into existing recording capability.
- Significant limitations on the scope and detail of data that can be captured. No overall capture of individual input actions or CCS content.
- Reduced data may not be taken off-site for subsequent analysis.
- No recording of individual face to face conversations without additional microphones.
- Unknown capability to integrate MSDF functions into existing C2 software.

3.3.12. Conclusions

The CSTC is capable of generating the broad base of complex scenarios that would be required for T&E purposes and has an infrastructure in place to support this. The CSTC is also in high demand at present, but its more extensive operational schedule means that the facility may be more available than the ORTT or NCOT for T&E. However, there is a potential problem of finding the necessary support personnel to assist in the running of scenarios.

The major disadvantage of the CSTC concerns its lack of data capture capabilities. These are limited in scope and utility compared with the ORTT and NCOT. Significant additional effort would be required to improve the existing data capture functions to fully support the specific



requirements of T&E. Even if that were to happen, it is not clear that data could be collected in volume over an entire scenario. Further, there would be need to manually log all T&E data injected into the scenario and integrate this manually after the fact with data recorded during the scenario.

Similar to the ORTT, the CSTC would probably be ill-used for running small-scale scenarios involving task strings, tasks and part tasks, because of the overhead in infrastructure required to do this. It is more suited to the collection of team based data under a simulated mission scenario. However, in this respect it falls short of the ORTT in terms of meeting T&E data capture requirements.

3.4. Ops Room of Ships in Harbour (the Wednesday War)

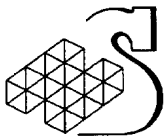
Within Maritime Operations Group One (MOG 1), located in Halifax, various operational ships participate in occasional co-ordinated harbour training exercises while alongside. Referred to as the *Wednesday War* due to the day of the week on which they are held, these exercises consist of simulated tactical warfare scenarios that are supported by functional operations rooms within participating ships integrated by live Link-11 and radio communications connectivity.

These exercises are not conducted every Wednesday, but rather at a frequency directed by the Commander of MOG 1 (CMOG 1) as determined by ships' programmes, which will dictate both the availability of ships to participate and the level of participation from each ship, as well as any special training required to help prepare for upcoming operations or exercises, such as live missile firings. CMOG1 will dictate the scope and intensity of the exercise, and these may vary from basic operator training to full combat team training. One ship will be designated as the Officer Conducting the Serial (OCS) for each exercise and will be responsible for developing an appropriate scenario, generating the required instructions, and acting as the control staff during the running of the scenario.

In order to participate, ships must have a functioning CCS, Link-11 and radio suite. Ships will implement a communication plan just as they would at sea. Normally UHF communications are used. All required tactical voice and Link-11 circuits will be established, as well as a separate voice circuit used by the OCS to co-ordinate the serial with other ships. Within each ship honest brokers known as "gamemasters" will relay or input information as directed by the OCS gamemaster. These gamemasters are normally combat operators, and will always be ship's own crew.

The CCS in each participating ship will be placed in "Sim", which facilitates the realistic simulation of weapons systems and other simulation functions such as the generation of CCS symbology once a radar "detects" a simulated contact. For this feature to work the ship must have its radar antennas rotating, but not necessarily emitting. When ships "detect" contacts that have been input by the gamemasters, they react in accordance with standard operating procedures. This would include Linking the track to other ships, as well as amplifying the track according to available real or simulated sensor information, scenario intelligence etc.

Each exercise normally takes place over a forenoon. The initial set-up will normally take about an hour as communications and Link are established, and background information is entered into the CCS. The actual scenario might run for 1 ½ - 2 ½ hours depending on the aim and complexity of the exercise. After the scenario the OCS will normally conduct a debrief over a radio circuit and invite input from all ships. A hard copy message summarising the exercise will be submitted by participating ships to CMOG1. Ships will also conduct internal debriefs. It is not common practise to use ships' internal data recording capabilities during these debrief sessions, but they could be



used. Ships could use C-SAVRAS, CCS History Record or any other data capture devises (bus-sniffer) that could be used by ships at sea, providing these are fitted.

Advantages

- Exercises are regularly scheduled.
- Real Ops Rooms are used so there is a high degree of face validity in terms of equipment capabilities and layout.
- Real ships teams are used, including technicians.
- Simulation facilitates realistic weapons engagements.
- Numerous Ops teams can participate simultaneously.
- Data can be captured the same as for a ship at sea.
- The infrastructure exists for these exercises to be conducted on a regular basis. Ops teams are familiar with their conduct.
- Supporting players available to play the necessary background roles to feed data to scenarios, move game pieces etc.
- Capability to insert T&E real-time data into scenarios.
- Numerous scenarios of varying complexity are resident in various ships and MOG 1.
- Available tools, expertise and knowledge to build scenarios.

Disadvantages

- T&E would need to receive priority to dedicate an exercise for T&E.
- There is limited capability to input realistic data to stimulate acoustic and ESM sensors.
- Only two pieces of radar video can be presented in each ship (a function of the SPS 49 air search radar). Otherwise, ships are fighting symbology.
- The expertise of various ships' teams to run scenarios and use the Sim function of the CCS is inconsistent.
- Additional video and audio data would have to be manually integrated into existing recording capability.
- Reduced data may not be taken off-site for subsequent analysis.
- No recording of individual face to face conversations without additional microphones.
- No capability to integrate MSDF functions into existing C2 software.
- The normal ships' routine carries on, including superfluous pipes over the main broadcast.

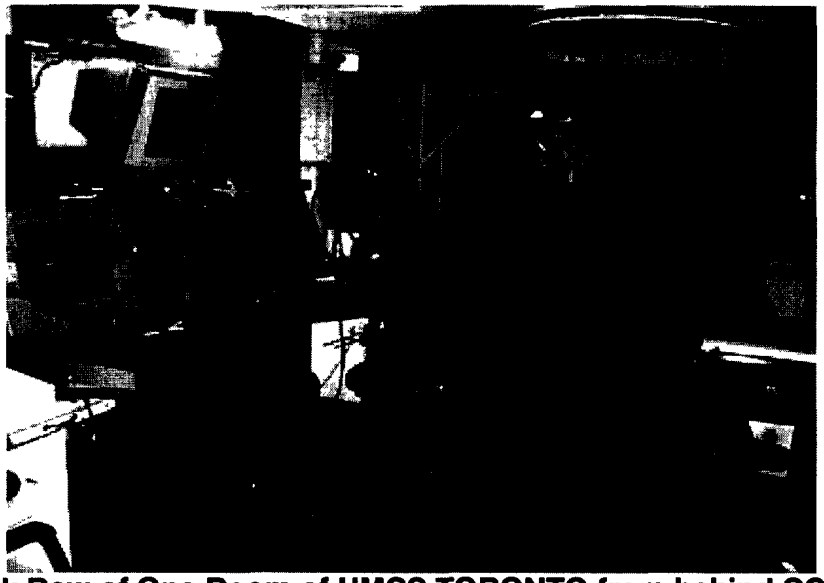


Figure 8: Back Row of Ops Room of HMCS TORONTO from behind CO position

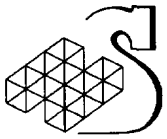
3.5. Ops Room of Ship during sea exercise

Essentially this environment would have the similar capability and limitations for T&E purposes as the Wednesday War configuration. This similarity exists both for the creation, running and data collection aspects of exercise scenarios. Some of the major differences obviously involve the additional elements of fatigue, stress and motivation that may be absent from harbourside exercises. This can be seen as adding to the validity of the evaluation. The sea exercise also has some advantages over the latter, for example:

- There is more dedicated technical support for the exercise.
- All positions are manned.
- There are no mundane interruptions that have nothing to do with the exercise of the type that may occur when the ship is at harbour.
- Real radar returns are present (e.g. if conducted in proximity to an airway, commercial traffic will be present on radar screens).
- Because the ship is on a 24/7 schedule, there is a potential for more availability for T&E purposes than a ship alongside.

Some of the disadvantages (over the harbourside Wednesday War) include:

- The only available technical support is on board ship (i.e. unlike at harbour, where additional resources may be brought in).
- The length and specific scheduling of sea trials may be difficult to integrate with T&E planning.
- High level authority would be required to permit T&E functions and associated personnel to be aboard during exercises.



3.6. Existing Navy C2 data capture and analysis systems

In this section we describe two systems (and related functionality) that have been developed to capture aspects of combat system data within the existing Ops Room infrastructure. These are the Combat System Audio Visual Recording and Analysis System (C-SAVRAS) and the System Analysis Simulation Evaluation (SASIE).

3.6.1. C-SAVRAS

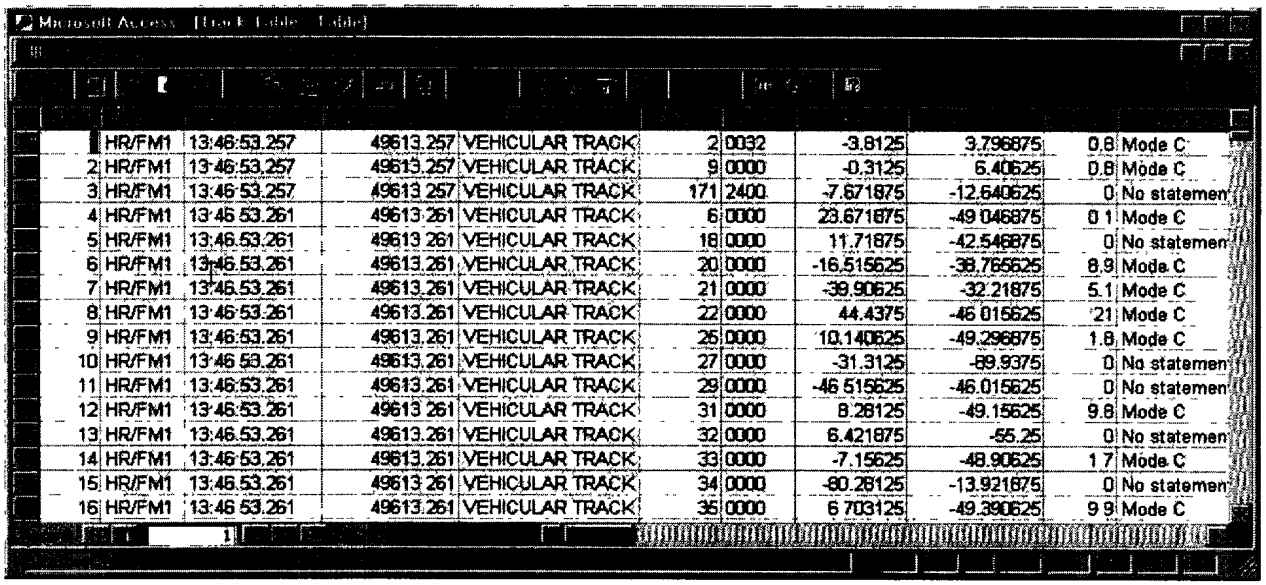
This system has two main capabilities: (i) video capture and replay of the content of all CCS screens in the Ops Room, and (ii) audio capture of communications on networks. Its output may be integrated with data captured by three other functions: History Recording, Bus Sniffer and SASIE.

The *video capture* capability of C-SAVRAS essentially provides a video recording of the content of any CCS console that can be subsequently played back upon a standard television monitor. It should be noted that the samples of playback that were provided showed considerable loss of picture quality for area, text and symbology data. Further, experienced Navy personnel are required to make their best estimate and interpret the displayed data. The captured video data can also be digitised and exported as MPEG files onto a CD. A maximum number of eight positions can be monitored, but this may be further reduced by the number of available video recorders. It takes less than an hour to set up the recording capability. Parallel recordings from separate workstations are not integrated into a common timebase. The audio capture on tape is achieved through the operators' microphone which is always "hot" plus whatever information that the operator receives through the headset. In playback there is no capability to identify the source of a message, instead it must be inferred from the context.

History record provides a record of information at the CCS level and includes messages, the state of the system, information displayed (e.g. track data) and console interactions, (e.g. QAB). The resulting data can be printed out as a serial list, dumped to a PC or converted to an ACCESS database using a parser. The original captured data (i.e. not the processed data) can only be replayed on a CCS and there is some limited control over playback speed. History Record has a limited capacity, which, in the worst case, would correspond to about 6-7 minutes of data for AAW functions. An underlying log clock records events to the millisecond level, but the reliability and accuracy of measurement to this precision is unknown. The user may also set the required scale of time measurement.

Logistical support is provided by ship-based resources and the quality of the data obtained is highly dependent upon the skill and experience level of the support staff.

The *Bus Sniffer* is a data monitoring system that captures data from the serial data buses that support the CCS and other systems. Using the HR and Bus Sniffer together provides the capability of generating a data file that comprises the following elements: event number, event time, source, message type (e.g. vehicle track) and details associated with the specific message type. An example of output of data captured by the bus sniffer is given below.



1	HR/FM1	13:46:53.257	49613.257	VEHICULAR TRACK	2	0032	-3.8125	3.796875	0.8 Mode C
2	HR/FM1	13:46:53.257	49613.257	VEHICULAR TRACK	9	0000	-0.3125	6.40625	0.8 Mode C
3	HR/FM1	13:46:53.257	49613.257	VEHICULAR TRACK	171	2400	-7.671875	-12.640625	0 No statemen
4	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	6	0000	23.671875	-49.046875	0.1 Mode C
5	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	18	0000	11.71875	-42.546875	0 No statemen
6	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	20	0000	-16.515625	-38.765625	8.9 Mode C
7	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	21	0000	-39.90625	-32.21875	5.1 Mode C
8	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	22	0000	44.4375	-46.015625	2.1 Mode C
9	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	26	0000	10.140625	-49.296875	1.8 Mode C
10	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	27	0000	-31.3125	-89.9375	0 No statemen
11	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	29	0000	-46.515625	-46.015625	0 No statemen
12	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	31	0000	8.28125	-49.15625	9.8 Mode C
13	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	32	0000	6.421875	-55.25	0 No statemen
14	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	33	0000	-7.15625	-48.90625	1.7 Mode C
15	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	34	0000	-80.28125	-13.921875	0 No statemen
16	HR/FM1	13:46:53.261	49613.261	VEHICULAR TRACK	35	0000	6.703125	-49.390625	9.9 Mode C

Figure 9: Example Data Table derived from the Bus Sniffer

3.6.2. SASIE

The Bus Sniffer and HR data can be also be integrated with the ***SASIE*** software developed by Thomson-CSF. This provides a capability to capture and record data via the bus sniffer between the CCS, sensors, Link 11 and weapons systems on HALIFAX Class ships. SASIE has its own replay and analysis tools and the data can be downloaded to a PC in the format of a sequential data items file. This file can also be transformed and replayed graphically to show data and events plotted in their spatial and temporal context. For example, the timeline data can be converted to a polar plot to allow geographical reconstruction of the ASW track history. Link 11 data are recorded in audio format then converted by software to text data for incorporation into the SASIE event file. Sonar data must be captured separately on magnetic tape and can only be replayed off-site. The sonar replay provides the acoustic data only, not the actions of the operator.

In general, SASIE is used to reconstruct events, usually associated with exercises by recreating an engagement timeline. Data items not captured by SASIE must be manually added. In general, most analyses of operational exercises tend to be qualitative rather than quantitative and there is no capability for statistical analysis, since the "n" is low and variability high, due to the large number of variables that are typically encountered during actual exercise conditions. SASIE is constrained currently by tape length to capture a maximum of 1000 data items in a single session. Sample SASIE data items are shown in the next figure.

Figure 10: Example Data Table derived from the SASIE

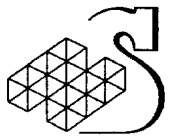
In addition to SASIE there are two other relevant analysis tools.

- **Timeline** (developed by MARLANT Operations Research) which provides a static representation of all engagement data versus time that is platform centric and show target versus ground truth in range, bearing, altitude/depth and presents sensor and command actions.
- **MEXANS** - Maritime Exercise Analysis Suite (DSTO-AUSTRALIA) is used to reconstruct and analyse events that occurred during a maritime patrol, exercise or trial. This tool plots 'ground truth' data against data recorded on board a combat system.

3.6.3. Summary of Advantages and Disadvantages

Advantages

- Ability to collect actual operational data under actual exercise conditions.
- Captures content of the CCS.
- Captures comm traffic.
- Could be implemented in the CSTC for data capture.
- Captures data on a common timebase.
- T&E data communication data could be input in real time.
- Tools are available for some aspects of data analysis.



- Data can be downloaded to a PC for analysis.

Disadvantages

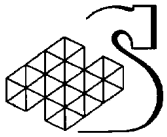
- Video replay data may lack the appropriate resolution to identify symbology and alphanumeric data for T&E needs.
- Severe limitations on length of data records, particularly for AAW.
- Requires trained personnel to set up and operate. Data interpretation and reliability is dependent upon skill level of support personnel.
- Availability of support personnel highly dependent upon ship scheduled activities.
- Could not accommodate the input of T&E data associated with sensors or tracks. That is, the only way a T&E track could be introduced would be through a Link 11 or audio comm.
- Can only operate in the CSTC or on board ship.

3.6.4 Conclusions

Overall, the above systems provide a capability for capturing operational data from Ops Room sized exercises under highly realistic conditions. The data capture and analysis capability has largely been developed to analyse missions qualitatively with a view to diagnosing and rectifying operational procedures and assessing the performance of the Ops Room team. Experience has been accumulated in using the systems and an infrastructure of support personnel to create, control and analyse exercises is in place. However, since the support personnel for control and data capture are part of a ship's company, their availability to provide support for T&E activities may be even less than the support personnel for CSTC or NCOT.

Given the overall size and availability of the ship-based infrastructure, it seems appropriate to only consider using C-SAVRAS and associated software in the context of at-sea exercises at the individual warfare level. The level of infrastructure could not be justified for capturing T&E data for single team members doing single tasks, sub-tasks or task strings. Further, the ability of the T&E team to provide real time control over scenario events is constrained by both operational circumstances and system capabilities. In addition, the large, uncontrolled variability associated with collecting data during operational exercises and the constraints on generating suitable sample sizes, precludes any rigorous statistical analysis of the data obtained.

SMEs knowledgeable in SASIE suggest that it would be most useful for analysing the detect-to-engage process at the air and surface warfare team level, and we concur with this assessment. The Wednesday War configuration may prove useful to rehearse sea trial scenarios prior to their conduct to iron out procedural issues. Furthermore, simple air detect-to-engage scenarios should be cross-validated between simulation environments to compare results.

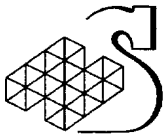


4. Availability of personnel as test participants

In general, since all of the facilities under consideration are under Navy jurisdiction and the expected test participants will be Navy personnel, then the same constraints and availability will apply to all environments. Dedicated access to such Navy personnel for the Ops Room at harbour or at sea may be more restrictive, because of other demands on such personnel. In general, Command authority will be needed to ensure that the COMDAT evaluation project is given priority for access to personnel. Further research into availability will be necessary once the specific requirements for test participants have been developed later in the project.

It remains possible that if some of the functionality of NCOT can be run on a workstation outside of NCOT, say at DCIEM, DREA or a contractor's site, then non-Navy personnel may be able to act as test participants. This activity would be limited to assessments of simple task functions only, where operational experience would not be necessary and adequate training could be provided.

Given the long term nature of the COMDAT program and the obvious advantages of a properly conducted simulator T&E environment systematically linked to sea trial data, it is suggested that there be a regular scheduled annual commitment of simulator time and support for T&E purposes.



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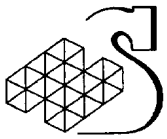


5. Overall Conclusions

5.1. Summary and of findings

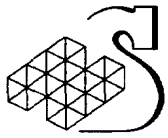
In order to provide a summary assessment and to allow comparisons across the potential test environments, a broad assessment was made of each environment against the core T&E requirements listed in section 2.6.3. This assessment was performed using the following three categories:

- the facility satisfies a particular requirement (indicated by a check mark below)
- the facility may or may not meet a requirement (indicated by a question mark)
- the facility does not meet the requirement (indicated by an "X" below).

The overall assessment was based upon a review by two members of the HSI® team of the detailed descriptive data and comments, and then a subjective assessment of which category to assign. In performing this task, certain of the descriptor items were invariably deemed to be more important than others, although no formal weights were assigned, in affecting the overall judgment. Once the overall assessment had been performed it was reviewed by the remaining members of the HSI® team and significant consensus was obtained. Some discussion emerged on a few items for some of the test environments that resulted in their evaluation category being changed.

The following table provides the result of this process and represents a high level summary of this assessment of the ability of each of the potential test environments to meet the needs of T&E. Numbers in a cell refer to subsequent explanatory notes.

	ORTT	NCOT	CSTC	Ops Room-Harbourside	Ops Room-Ship at Sea
Availability of the facility	? 1	? 1	? 1	? 2	✗
Appropriate Workstations (to the specific T&E paradigm)	✔	✔	✔	✔	✔
Flexible arrangement of workstations for T&E	✔	✔	✗	✗	✗
Capability to simulate the functions required to support the team role or roles under analysis	✔	? 3	✔	✔	✔
Capability to create T&E scenarios	✔	✔	✔	? 4	? 5
T&E personnel can create scenarios more or less autonomously	✗	✔ 6	✗	✗	✗
Capability to control T&E scenarios in real time	✔	✔	✔	? 7	? 7
Capability to capture data to the required level of precision	✔	✔	? 8	? 8	? 8
Capability to capture data reliably	✔	✔	? 8	? 8	? 8



Capability to capture the required volume of data	✔	✔	✖	✖	✖
Capability for reducing and analysing the data	✔	✔	?9	?9	?9
Capability to run repeated trials for limited Ops Room positions	✔ 10	✔	✔ 10	✖	✖

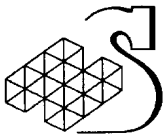
Explanatory Notes:

1. These facilities are in high demand for training purposes. If time is to be allocated for T&E purposes then it will need to be booked in April for that particular calendar year. In the present year, there may be as few as 3-4 days available in the ORTT.
2. Access to this environment may be even more difficult since it depends on the availability of at least two ship's support personnel, as well as the constraints imposed by ongoing training exercises.
3. As yet, NCOT remains unproven in its ability to simulate functions performed at the warfare team level (and higher) that require multiple, interacting Ops Room personnel supported by the necessary game controllers and players.
4. Scenario creation would be dependent upon the development of scenarios initially for the CSTC, since there are significant constraints on the availability of shipboard personnel to assist this process.
5. Scenarios at sea appear to be limited to specific Navy training requirements. At present, these tend to be narrow in scope (e.g. weapons and other responses to live targets) and do not meet the required range of scenarios that would be needed for T&E.
6. Would require suitable training by MD
7. Such exercises (especially at sea) are subject to a number of uncontrollable variables that prevent even a well-planned scenario from being executed without variance over repetitions.
8. The existing data capture tools are not designed to meet the more demanding requirements of T&E. Video data are of low resolution and require subjective interpretation by experienced personnel. The general ability to capture reliable data is highly contingent upon the skill level and experience of game controllers and analysers.
9. This capability is limited to existing functionality designed for Navy needs. It would need to be expanded and further developed to meet the requirements of T&E.
10. Limited ability to re-configure workstations for different roles.

5.2. Fidelity Issues

As we have noted in Matthews et al (1997), the fidelity requirements of a test bed can range from the simple to the complex. Four levels of test bed configuration were identified.

- Level 1: low fidelity representation of console, screens, or floor layout,
- Level 2: static test screens representing basic system part task functions,



- Level 3: part system functionality with task strings performed interactively between positions,
- Level 4: fully functional prototypes configured for typical team operation.

Based on the above, NCOT appears to have a fidelity at least at level 3 and the ORTT, CSTC and Ops Rooms alongside or at sea at level 4.

In general, it appears possible to rank order the fidelity of the four test environments from lowest to highest as follows: NCOT< ORTT=CSTC<Ops Room alongside< Ops Room at sea. Of course, the latter two rankings are hardly surprising.

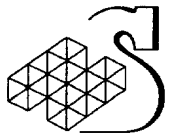
NCOT has lower fidelity mostly in terms of the physical aspects of the facility, that is the hardware itself, the look and feel of the hardware, the layout of the workstations and ancillary equipment and the mode of communications. However, from a functional perspective the system appears capable of being able to support assessment of complex task strings involving teams. The major increase in fidelity that is found in the ORTT and CSTC is due to its very close similarity to the physical environment of a HALIFAX Class Ops Room. A task environment that involves the whole Ops Room personnel interacting, moving and communicating with each other, as they would at sea, can be reproduced with a high degree of fidelity in the ORTT and CSTC, but that does not appear possible for NCOT, or to a much lesser degree.

5.3. Analysis of findings

Based upon what we have learned to date, we have made a preliminary assessment about the most appropriate environment for performing the various types of T&E Functions, as indicated in the table below.

This assessment is based on the general approach recommended in Matthews et al (1997) in which the test environment is matched to the testing needs. Further, there is an effort to avoid wasting valuable resources by proposing an environment that has a higher fidelity or level of data collection sophistication than a specific T&E paradigm might require (e.g. using the ORTT for sub-tasks).

Source	Task performance (timing and accuracy)	Communication measures	Situation awareness	Decision Making	Baseline Data
Single player					
Sub-task	NCOT	NCOT	NCOT	NCOT	
Task	NCOT	NCOT	NCOT	NCOT	
Task string	NCOT	NCOT	NCOT	NCOT	
Function	NCOT	NCOT	NCOT	NCOT	
Warfare team					
Sub-task	NCOT	NCOT	NCOT	NCOT	
Task	NCOT	NCOT	NCOT	NCOT	
Task string	NCOT	NCOT	NCOT	NCOT	
Function	ORTT	ORTT	ORTT	ORTT	



Full Ops Room					
Sub-task	ORTT	ORTT	ORTT	ORTT	
Task	ORTT	ORTT	ORTT	ORTT	CSTC/C-SAVRAS
Task string	ORTT	ORTT	ORTT	ORTT	CSTC/C-SAVRAS
Function	ORTT	ORTT	ORTT	ORTT	CSTC/C-SAVRAS

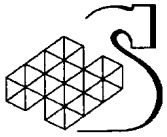
As can be seen from the above table, it is recommended that the T&E effort be concentrated on two facilities. NCOT for paradigms up to the level of task strings performed by multiple players and the ORTT for everything more complex. It is possible that the functionality of NCOT may also accommodate complete operational functions at the Warfare team level. However, rigorous proof of concept will be required to determine whether or not NCOT can actually meet the T&E requirements at the level of team functions.

At this time, the uses of any of the potential environments that involve the existing Ops Room equipment, (that is the CSTC and harbourside or at sea configurations) is not recommended. There are several reasons for this. First, there are concerned about the level of precision, quality and quantity of data that can be captured for T&E purposes. For example, the video playback capability of C-SAVRAS does not seem adequate for assessing the detailed content of the CCS. Also we have been told that the quality of the data is highly dependent upon the skill level of the support personnel. The volume of data that can be collected is constrained by existing limits of the recording systems. Second, it may be difficult to integrate new functions at the software and hardware level associated with MSDF into the existing system. (Just as it has been difficult to integrate data capture methods, resulting in less than optimum solutions being implemented, such as the bus sniffer). Third, availability of the harbourside and at-sea configurations is likely to be highly constrained and unlikely to meet the somewhat extensive testing requirements for evaluating MSDF. Fourth, it appears that data collection at sea is at the mercy of a variety of uncontrolled variables that may preclude the collection of reliable, repeatable and stable performance data.

The CSTC/C-SAVRAS combination may be useful for providing some baseline data at the gross function level, for example the time it takes for the detect-to-resolve cycle, and for assessing communication patterns and loads in a variety of operational tasks. Further, there may be some useful data in existing exercise databases captured in the facility or at sea that may provide some broad basis for comparing the impact of MSDF.

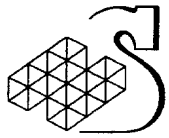
With respect to NCOT, there is a reservation at this time in considering it as a primary candidate for T&E needs in terms of its ability to actually deliver the required functionality. It should be remembered that much of what we have learned is by word of mouth from the MD company representative and the documentation that describes the proposed functionality. There is also currently very little accumulated experience in using the facility for anything other than computer based training. Thus, there is a very large question at present concerning the NCOT's proven ability to allow development of the required T&E software, to meet requirements for the set up and control of data collection sessions, and to reliably collect data that are in a format amenable to analysis. Nevertheless, based upon the documentation on system capabilities, we remain hopeful that as NCOT is developed that it will realise its potential for T&E activities over the lengthy timeframe of the COMDAT program.

The ORTT appears to provide all of the basic requirements for T&E purposes for complex operational functions and would be the clear first choice for running team scenarios that involve functions at the warfare team level (e.g. detect-to- resolve) and for all scenarios involving the



complete Ops Room team. It is not considered a better alternative for T&E at the level of individual tasks and task strings for several reasons. First the level of overhead may be unwarranted for such relatively straightforward T&E paradigms. Second, it does not lend itself quite as well as NCOT to flexible configuration for multiple subjects to be tested in parallel doing the same task on multiple workstations.

Finally, there are some major concerns about being able to access the various facilities and in obtaining the level of support required to run T&E scenarios. This concern stems from the high demand from the Navy to meet their training requirements, the continuing use of NCOT and the ORTT by the commercial developers and the constraints on availability of support personnel. The most optimistic assessment is that the ORTT could be made available for 3 days in the current calendar year, if the reservation were made before the end of April. NCOT may be more available, but again early booking would be required.



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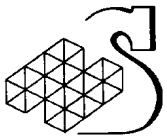
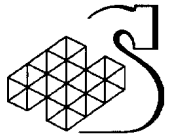


6. Existing MOPs

Quantitative MOPs that would provide baseline measures for T&E purposes do not appear to exist. Some quantitative MOPs concerning operational functions such as weapons responses to incoming threats have been developed to collect selected data during live exercises at sea. Such data are probably of limited value for baseline purposes. First, they tend to be highly sensitive and hence access may be a problem. Second, the sample size is very small. Third, the reliability of the data may be compromised by a variety of uncontrolled variables that tend to occur with live exercises.

For the ORTT, and certainly for NCOT, there does not appear to be as yet an accumulated body of quantitative data that could be readily accepted as representing baseline performance. We have yet to see samples of data sets that have been collected in the CSTC during simulation exercises. However, given the purposes of such data collection (training feedback), concerns we have expressed earlier over the level of precision required for T&E purposes and the fact that we would be trying to fit the data after the fact to the T&E paradigm, suggests that even if such data were available in quantity its usefulness would be limited.

Hence, the thrust of the future work to develop MOPs will guided by the general performance areas that seem to be of operational interest, rather than the adoption of existing metrics. This development process will also be guided by previous work by Human*systems* and DCIEM in this field, work underway at DREV and the available literature on measuring performance in C2.



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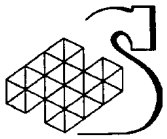


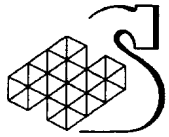
7. Next Steps

Our preliminary recommendation is to set up a limited proof of concept trial for NCOT. This would involve the following steps:

- Assemble a small T&E team. Walk through selected individual and small team existing scenarios with trained operators and trainers for familiarisation purposes.
- Work with Navy, and possibly MD, personnel to develop (or select from existing) scenarios and scenario fragments.
- Develop a small cross section of MOPs for these scenarios.
- Proof the scenarios in NCOT and collect sample data.
- Assess ability to run and collect data on single players/single tasks, two interacting players on single tasks and multiple players on the same single task.
- Provide MD with specifications for reduction of data from sample data files.
- Analyse sample data.

We also strongly recommend that DCIEM initiate the process of reserving space with the necessary naval authorities for carrying out the above steps in NCOT in the Fall of 2001 and also make reservations for 2002 in both NCOT and the ORTT. Our preliminary suggestion is that testing will require a full working week (five days) in each facility.

Finally, whether dealing with NCOT or the CSTC, funds will be need to be found to support the commercial development of T&E software by MD and LM. The specific requirement for this will be detailed in the final deliverable for this project.



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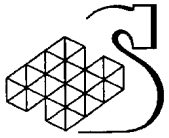

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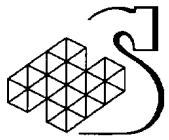

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Annex A: Summary Tables of Evaluation Methods and Measures

Functionality	• Functional requirements *- Present* *- Easy to use* *- Useful*	• Requirement check list 5 point rating scales completed by SME and HF specialists *- Function or feature present YES/NO* *- Mean ratings for usability and utility for critical tasks* *(* 50% evaluation see note above)*	• Requirement check list 5 point rating scales completed by final participants *- Function or feature present YES/NO* *- Mean ratings for usability and utility for critical tasks* • Performance data (Prioritize by results at story board stage) *- Time to use function or feature* *- Accuracy of results using function* - etc (* 40% evaluation)	• Requirement check list 5 point rating scales completed by final participants *- Function or feature present YES/NO* *- Mean ratings for usability and utility for critical tasks* (* 10% evaluation)
Interface	• User interface meets HF guidelines for *- Legibility of text and symbols* *- Coding in terms of color, shape, etc* *- Menu characteristics* *- Window characteristics* *- Keyboard characteristics* - etc	• Style guide check list 5 point rating scales completed by SME and HF specialists • *Characteristic.* *- present YES/NO* *- Mean ratings for compliance for critical tasks* *- Mean ratings for acceptability of trade-off(s)* *(*50% evaluation)*	• Style guide check list 5 point rating scales completed by final participants • *Characteristic.* *- present YES/NO* *- Mean ratings for compliance for critical tasks* • Performance data Prioritize by results at story board stage *- Time for generic sub-tasks and activity strings* *- Response time to alerts* - etc (* 40% evaluation)	• Style guide check list 5 point rating scales completed by final participants • *Characteristic* *- present YES/NO* *- Mean ratings for compliance for critical tasks* *- Mean ratings for acceptability of trade-off(s).* • Performance data. Prioritize by concerns identified in Test Bed *- Time for generic sub-tasks and activity strings* *- Response time to alerts* - etc (* 10% evaluation)

Table A1: Potential Evaluation Methods and Measures (Function Usability)

(* estimated % of domain subsection evaluated using this configuration)

Evaluation Domain		Evaluation Methods and Measures Evaluation Configuration (* estimated % of domain subsection evaluated using this configuration)		
USER FIT	Criteria	Story Board / Table top mock-ups (Whole or part system + imaginary context) << Evaluation Scenario(s) task-by-task >>	Test Bed (part system + part context) << Evaluation Scenario(s) task-by-task >>	Full Scale Simulation or Field Trial (full system + full context) << Evaluation Scenario(s) task-by-task >>
Situation Awareness	• For each task relevant variable users can promptly, accurately and completely - *Acquire timely information* *Consult appropriate sources.* *Detect relevant cues* - *Comprehend information* - *Predict immediate future* - *Maintain information* *Store (remember)* *Recall (retrieve)*	• Questionnaire data 5 point rating scales completed by SME and HF specialists *Mean estimates given by SME and HF specialists* *of probability of typical users being able to fulfill "Criteria" for critical tasks for each job position* *(5% evaluation)*	• Questionnaire data* 5 point rating scales completed by trial participants *Mean ratings given by trial participants* *for "Criteria" for critical tasks for each position* • Performance data "Probe" questions to determine speed and accuracy of information acquisition Observed response to new information Observed source consultation - *% checklist information sources consulted* - *Time to acquire relevant information* - *Comprehension of information acquired* - *% participants responding appropriately to info* - *Response time to information status changes* - *SME ratings of appropriateness of response* - *Time to retrieve information (etc) (60%)*	• Questionnaire data 5 point rating scales completed by trial participants *Mean ratings given by trial participants* *for "Criteria" for critical tasks for each position* • Performance data (concurrent tasks) "Probe" questions to determine speed and accuracy information acquisition Observed response to new information Observed source consultation - *% checklist information sources consulted* - *Time to acquire relevant information* - *Comprehension of information acquired* - *% participants responding appropriately to info* - *Response time to information status changes* - *SME ratings of appropriateness of response* - *Time to retrieve information (etc (35%)*
Communication Effectiveness	• For each task and message type, users can minimize - *Communication time for* *Preparation* *Transmission* *Receipt* *Response* – *Requests for clarification* – *Repeated messages* – *Errors in* *Transmission* *Content*	• Questionnaire data. 5 point rating scales completed by SME and HF specialists *Mean ratings given by SME and HF specialists for "Criteria" for critical tasks for each job position* *(* 5% evaluation)*	• Questionnaire data 5 point rating scales completed by trial participants *Mean ratings given by SME and HF specialists for "Criteria" for critical tasks for each job position* • Performance data (isolated tasks) - *% time spent on communication* - *Mean transmissions/system function* - *Clarifications/100 messages* - *Repeats/100 messages* - *Mean time end of inquiry to start of response* - *Transmission errors/100 messages* - *Content errors/100 messages(* 20% evaluation)*	• Questionnaire data 5 point rating scales completed by trial participants. *Mean ratings given by SME and HF specialists for "Criteria" for critical tasks for each job position* • Performance data* (concurrent tasks) - *% time spent on communication* - *Mean transmissions/system function* - *Clarifications/100 messages* - *Repeats/100 messages* - *Mean time end of inquiry to start of response* - *Transmission errors/100 messages* - *Content errors/100 messages* 75% evaluation)*
Mental Workload	• For all task combinations and durations, the system permits users to manage mental workload to - *Maintain effective performance* – *Avoid over-load* – *Avoid under-load*	• Questionnaire data. 5 point rating scales completed by SME and HF specialists *Mean workload ratings given by SME and HF specialists for "Criteria" for critical tasks for each job position.* *(* 5% evaluation)*	• Questionnaire data 5 point rating scales completed by trial participants SME ratings on-line or post event *Mean workload ratings by participants and SMEs (on-line or post-scenario) for "Criteria" for isolated tasks.* *(* 35% evaluation)*	• Questionnaire data. 5 point rating scales completed by trial participants SME ratings on-line or post event. *Mean workload ratings by participants and SMEs (on-line or post-scenario) for "Criteria" for concurrent tasks for each job position and different traffic volumes* *(* 60% evaluation)*
Physical Fit	• Relevant layout features for each task [console (person), cell(team) & centre (crew)] fit users physical needs for - *Communication links* *Visual (line of sight, eye movt)* *Auditory* - *Movement links* *Hand-arm, Whole body* - *Minimize musculo-skeletal stress.*	• Guide line check list Anthropometric overlays Link analysis 5 point rating scales completed by SME and HF specialists - *Estimated workload ratings by SME and HF specialists for "Criteria" for each job position.* - *Predicted % of users able to complete critical links (*30% evaluation)*	• Questionnaire data* 5 point ratings of discomfort and acceptability completed by trial participants Observer ratings of video Fitting trials 5-95 percentile users - *Mean acceptance and discomfort ratings by participants and SMEs for "Criteria" for isolated tasks* - *Ability of 5th and 95th percentile users to complete critical links.* *(* 40% evaluation)*	• Questionnaire data 5 point ratings of discomfort and acceptability completed by trial participants Observer ratings of video Fitting trials 5-95 percentile users - *Mean acceptance and discomfort ratings by participants and SMEs for "Criteria" for concurrent tasks* - *Ability of 5th and 95th percentile users to complete critical links.* *(* 30% evaluation)*

Table A2: Potential Evaluation Methods and Measures (User Fit)

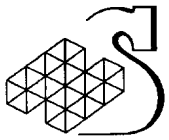
[illegible]	• For given mission type, users can: - Access required information - Review information in context - Develop / maintain awareness of situation - Identify objective(s) - Match resources to objective - Generate alternative options - Evaluate and prioritize alternatives - Present alternatives to others - Decide COA.	• HF and SME estimates and ratings of acceptability for - Time statistics for information access - % completeness of information - Situation Awareness (see other sections) - Impact on critical path for other functions (5% evaluation)	• High level functions performed as series of task strings Recorded data plus SME observer and trial participant ratings of acceptability of. – Situation Awareness (see other sections) - Time statistics to identify objective(s) - % errors in determining objective(s) - Time statistics on generation of options - Time statistics on evaluation of options - Time statistics on presentation of options – Suitability of options chosen – Impact on critical path for other functions (30% evaluation)	High level functions in operational context • Recorded data plus SME observer and trial participant ratings of acceptability of - Situation Awareness (see other sections) - Time statistics to identify objective(s) - % errors in determining objective(s) - Time statistics on generation of options - Time statistics on evaluation of options - Time statistics on presentation of options - Suitability of options chosen - Impact on critical path for other functions (65% evaluation)
[illegible]	*see Table A11 above "Potential Evaluation Methods and Measures User Fit"*			

Table A3: Potential Evaluation Methods and Measures (Operational Impact)

Annex B: List of T&E Requirements

The first column expands upon the general requirements outlined in the body of the text and the second column contains comments and issues concerning the requirement.

Logistics	
1.1. Availability of facility	Booking process (advance notice etc) Program (annual?) Sharing vs exclusive Duration of booking 24/7, etc.
1.2. Set up time for facility	How much work / time to prepare from current status.
1.3. Number of CCS workstations	All linked?
1.4. Ops Room Team simulated	OP/SUP/WD/ORO/CO Specialities (EW/SONAR/ETC) Outside sources (bride, helo, etc)
1.5. Suitable system docs & manuals available?	Availability: what, where, removable? Suitability: Contents, Set up vs maintenance.
1.6. Availability of Technical/Controller support for:	
1.7. Software/hardware during preparation	Help with set up of equipment Scenario development and set up Set data capture equipment, software, analysis
1.7.1. Software/hardware during testing	Maintenance / repair of crashes Ad hoc changes to scenario (Unplanned insertion of data)
1.7.2. Control scenario play	Availability of controller staff as scenario players, war game directors?
1.7.3. Software/hardware during analysis	Data capture and analysis, downloading, configuring for other analysis software, etc.
1.7.4. Trg of HSI® test personnel in technical issues	How are HSI® staff to be trained
1.8. Availability of Personnel as test participants	
1.8.1. Number	How many can we get?
1.8.2. Experience / qualifications	What range of experience and qualification (e.g. students only?)
1.8.3. Individuals or teams	Will they have worked together before?
1.8.4. Notice required	How far ahead is booking required?
1.8.5. Range of Ops Room team represented	Different availability for different levels? Are "filler" personnel available for part task simulation?
1.9. Video recording available	
1.9.1. Type of video	# workstations covered, duration of recording, Time coord with different video / audio /other sources. Wide area coverage Macro coverage / resolution of CCS screen data Quad coverage Tracking (pan, zoom, etc) Low light / red light
1.9.2. Eye tracking capability	Video, other
1.10. Audio recording available	
1.10.1. Type of audio	# workstations covered (internal vs external to OR), duration of recording, Time coord with different video / audio /other sources. identification of position(s), incoming vs outgoing audio quality (noise, etc) off net speech in OR



1.11. Information exchange (is it represented?)	
1.11.1. Internal net in OR	Who can be on it in trainer?
1.11.2. External nets to Ops Room on ship	Who can be on it trainer?
1.11.3. External nets to ship	Who can be on it trainer?
1.11.4. Text	What types of text messages? Level of text message activity?
1.11.5. Face to face in OR	Direct voice contact in OR?
1.11.6. Other information exchanges	State boards Manuals / Charts / Tacpacs / Post its / etc.
1.12. Customise environment for data collection	Ability to add COMDAT prototype equipment / software Technical support for this?
1.12.1. Extra audio and video	Add extra audio / video data capture devices
1.12.2. Add on software modules	Ability to add on software modules to interject data into canned scenarios/simulations
1.13. Standalone keypads, notebooks or PDA's for data entry by participants or observers?	Eg for workload ratings at intervals Or for response to freeze probes or for diary entry
1.14. Reliability of system	Types of reliability problems Crash risk Repair time / typical down time Repeatability of scenarios
1.15. Space for observers	Is there space for more people to observe / capture data. Worst case = one observer at each work station.

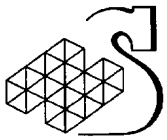
2. Experimental control	
2.1. Environmental control (lighting, acoustics, thermal, motion)	Adjustability and control over lighting Adjustability and control over acoustics
2.2. Pre-packaged scenario	Availability? Modifiabilty? (e.g. freeze and tracking probes)
2.3. Complexity of scenarios	
2.3.1. Mission types	Location, threat type, TG configuration, OOTW, Aid civil power, etc
2.3.2. Mission segments	Part task breakdown capability
2.3.3. Number of players	Multiple players on single task, or single player multiple roles.
2.3.4. Number and types of assets	How many and what types en / fr / neutral ships, a/c, weapons, sensors, etc. Can these be varied?
2.3.5. Number and levels of team roles	Can these be varied?
2 4. Ability to run pre-packaged scenario to a defined timeline	Certain events at certain points on time line, regardless of player response. Data to be collected on that time line.
2.5. Ability to control select variables in real time	Ad hoc failures of Circuit or Net, workstation to fail, weapon system to fail.
2.6. Ability to interject probes in real time	Freeze probes Tracking probes
2.7. Ability to stop/re-start scenarios	
2.8. Ability to backup/re-run scenarios	
2.9. Ability to dynamically modify scenario depending upon responses	If x then y e.g. if fails to respond to threat, re-insert same threat later If a then b
2.10. Comms among experimenters / controllers	Can observer / experimenter selectively provide instructions, ask questions over net to players or observers or controllers? If not can this be added?

3. Data Collection	
3.1. Ability to capture physical actions:	
3.1.1. Movement in OR	e.g video, movement sensors in Ops Room or on person.
3.1.2. Workstation	
3.1.1.1. Keystrokes	Quad video, software based?
3.1.1.2. Screen navigation	Quad video, software based?
3.1.1.3. Comm buttons/pedals	On net, off net?
3.1.3. Other devices	Lap tops, PDAs, key pads, etc.
3.2. Ability to capture information exchange	
3.2.1. Written	Non CCS: formal (msg pad, format), informal (post it note, etc). Timing, content, source, addressee(s)
3.2.2. Verbal	Network vs non network Timing, content, source, addressee(s)
3.2.3. Visual	Face to face, stateboards, non CCS info sources (e.g. GCCS, plot, manuals, charts, etc) Timing, content, addressee(s) i.e. what is source of information.
3.3. Capability of recording contents of CCS Display	Time line, screen dump vs data content.
3.4. Ability to capture timing of actions and other events to required accuracy	Timeline resolution, registration to other workstations, etc.
3.5. Availability of observers as assessors.	Instructor SMEs to act as observers and interpreters for real time or post hoc review.
3.6. Ability to capture data in post analysis (by re-running scenario)	Can responses to scenario be re-run? How sophisticated, comprehensive is this capability? Can tempo and/or content be modified for each re-run. Can data sets be aggregated?
3.7. Existence of training MOPs	Which Ops Room positions? Doc available.

4. Data Storage and Analysis	
4.1. Ability to store data in a format that is readily exported for analysis	Can data be used in other analysis display software applications?
4.2. Ability to analyse data	Existing or on –site data analysis capabilities?
4.3. Ability to display data	Existing or on –site data display capabilities?
4.4. Reliable data storage	Types of reliability problems Crash risk Data formats Compatibility with
4.5. Access to data after collection	Can data be taken off –site? Security issues?

5. Availability of existing training MOPs	
5.1. Objective	Time and accuracy based metrics excluding rating scales
5 2. Subjective	Subjective instructor based (criteria, rating scales, etc).
5.3. Machine-based	Automatic implementation of objective measures above?

6. Environment and General Fidelity	
6.1. Interruption free	Unbroken sequences? Intrusive observers?
6.2. Appropriate illumination	Colour, level
6.3. Appropriate sound levels	Weapons, engine noise, talk
6 4. Appropriate Ship motion	Changes in direction, interference with movement, sickness?
6.5. Appropriate clothing	Is clothing representative (hoods, gloves, heat,)
6.6. Layout appropriate to Ops Room(where required)	Lines of sight to stateboards, space for notes, etc.
6.7. Range of tasks	Can all tasks be simulated? What tasks cannot?
6.8. Tempo of operations	Same pace as operations?



6.9. Communication	e.g. volume and type of text messages, responsiveness, sound, level of radio comms, etc.
6.10 Complexity	e.g. multi-tasking
6.11. Workload	Is workload representative
6.12. Duration	Sustained operations, time of day, fatigue.
6.13. Manning levels	Realistic for operation
6.14. Threat levels	Are they realistic?
6.15. Force configuration and role.	Enemy and friendly.
6.16. Stress	Type, intensity.
6.17. Mission (s)	e.g. OOTW players. Multi-national, Aid to civil power.
6.18. Social dimensions	Use of intact teams? Levels of authority? Implications of decisions? Cognitive / affective conflict? Trust / confidence in others. Team mental models?
6.19. Other	Quals / experience of participants? Background knowledge of mission prior to start scenario.

Annex C: Data collected for each of the potential test environments.

C.1 ORTT

Logistics		
1.1. Availability of facility	Booking process (advance notice etc) Program (annual?) Sharing vs exclusive Duration of booking 24/7, etc.	ORTT: (16 hours day) for 20001/2002; 8 hours day training/ 8 hours L-M -5 days week. Must be booked by March-April for next year schedules Starts scheduling in March – done by September Training given first priority: blocks out, March, April, Sept, Oct for CFNOS. Also vacations. Priority with LM determined in advance. In future LM needs will reduce. Immediate use is extensive for shakedown and building scenarios ORTT priority is Megaphase, Marlants, OTTs (4x5days), sub-team training, Equipment is available during spare time in megaphase, but not staff for running the trainers; TTC staff are needed for scenarios logistics. Needs would be reduced if only looking at one warfare area. Facility is now 30% overbooked. Could fit in a 3 day pilot – some time this year; air warfare side is most congested right now. Longer blocks available next year. Notes: Data would be available from existing training courses to do baseline. NCOT will reduce some of this load when it fully comes on line because it does some of the basic equipment familiarisation. NCOT – lots of free time now – but will take over ORTT/CSTC capability in future and should free up time. However, this excess capability is likely to be absorbed by existing Navy needs.
1.2. Set up time for facility	How much work / time to prepare from current status.	Half day, one hour for existing scenarios
1.3. Number of CCS workstations	All linked?	Full OR less CANEWS, CANTASS GMCS. 10 workstations in each of two rooms +bridge (only used as a simulation input)
1.4. OR Team simulated	OP/SUP/WD/ORO/CO Specialties (EW/SONAR/ETC) Outside sources (bridge, helo, etc)	CO, ORO, SWIC, ASWC, ASAC,RT1,RT2, TrackSup, EWS, SCS, Bridge
1.5. Suitable system docs & manuals available?	Availability: what, where, removable? Suitability: Contents, Set up vs maintenance.	Yes on CD.

1.6 Availability of Technical/Controller support for :		
1.6.1. Software/hardware during preparation	Help with set up of equipment Scenario development and set up Set data capture equipment, software, analysis	Yes –depends on schedule – and length. One game takes one month to develop from scratch. But existing scenarios can be readily implemented. Most of the scenarios will be available within a year. Many of the gaming scenarios are available now (e.g. "clockwork mouse".)
1.6.2. Software/hardware during testing	Maintenance / repair of crashes Ad hoc changes to scenario (Unplanned insertion of data)	Yes Yes (but event must be in database)
1.6.3. Control scenario play	Availability of controller staff as scenario players, war game directors?	Yes –depends upon schedule 5 days/0800-1600
1.6.4. Software/hardware during analysis	Data capture and analysis, downloading, configuring for other analysis software, etc.	Analysis after hours – would need to be done by LM
1.6 5. Trg of HSI® test personnel in technical issues	How are HSI®™ staff to be trained	Trained for audio-visual – on the job for data insertion Yes.
1.7. Availability of Personnel as test participants		TBD
1 7 1. Number	How many can we get?	
1.7 2. Experience / qualifications	What range of experience and qualification (e.g. students only?)	
1.7.3. Individuals or teams	Will they have worked together before?	
1.7.4. Notice required	How far ahead is booking required?	
1 7 5. Range of OR team represented	Different availability for different levels? Are "filler" personnel available for part task simulation?	
1.8. Video recording available		Yes –from 2 cameras
1 8.1. Type of video	# workstations covered, duration of recording, Time coord with different video / audio /other sources. Macro coverage / resolution of CCS screen data Tracking (pan, zoom, etc) Low light / red light	Global view of all workstations with wide area coverage Length of scenario Yes No (this is captured by software) No Yes
1.8.2. Eye tracking capability	Video, other	Yes – but independent
1.9. Audio recording available		
1.9 1. Type of audio	# workstations covered (internal vs external to OR), duration of recording, Time coord with different video / audio /other sources. identification of position(s), incoming vs outgoing audio quality (noise, etc) off net speech in OR	2 mikes for general audio (part of audio) – some individual voices could be captured– if the area is quiet. Captures all internal net comms both ops and sim co-ordinated on time base. Comms data are associated with each console position

1.10. Information exchange (is it represented?		
1.10.1. Internal net in OR	Who can be on it in trainer?	Yes
1.10.2 External nets to OR on ship	Who can be on it trainer?	Yes
1.10.3. External nets to ship	Who can be on it trainer?	Yes
1.10.4. Text	What types of text messages? Level of text message activity?	Yes: would need either physical handoff or sent through CCS
1.10.5. Face to face in OR	Direct voice contact in OR?	Only if ops room quiet –difficult to implement for ORS but might be acceptable for ORO, either on system mike or room mikes
1.10.6. Other information exchanges	State boards Manuals / Charts / Tacpacs / Post its / etc.	Yes Manuals-Y, Charts-Y, Tacpacs-Y, Post its-Y
1.11. Customise environment for data collection	Ability to add COMDAT prototype equipment / software Technical support for this?	No, only as simulation and this would need to be contracted with LM
1.11.1. Extra audio and video	Add extra audio / video data capture devices	Yes
1.11.2. Add on software modules	Ability to add on software modules to interject data into canned scenarios/simulations	Would need to be contracted with LM
1.12. Standalone keypads, notebooks or PDA's for data entry by participants or observers?	Eg for workload ratings at intervals Or for response to freeze probes or for diary entry	Yes – for dedicated trials – not during training Yes
1.13 Reliability of system	Types of reliability problems Crash risk Repair time / typical down time Repeatability of scenarios	Unpredictable, since system is still in early days Can do workarounds – may need to add 25% extra capacity to allow for this. Yes
1.14 Space for observers	Is there space for more people to observe / capture data. Worst case = one observer at each work station.	Yes

2. Experimental control		
2.1. Environmental control (lighting, acoustics, thermal, motion)	Adjustability and control over lighting Adjustability and control over acoustics	Yes N – but representative; warmer-no external noise eg weapons
2.2. Pre-packaged scenario	Availability? Modifiabilty? (e.g. freeze and tracking probes)	Yes Tracking yes-Freeze-tracking probes OK by voice or CCS
2.3. Complexity of scenarios		
2.3.1. Mission types	Location Threat type TG configuration OOTW, Aid civil power, etc	Not now –could be done Anything Anything including other nations Yes
2.3.2. Mission segments	Part task breakdown capability	Yes
2.3.3. Number of players	Multiple players on single task, or single player multiple roles.	Max is 2. 3 in the case of Air. Front 4 are interchangeable.

2 3.4. Number and types of assets	How many and what types en / fr / neutral ships, a/c, wpns, sensors, etc. Can these be varied?	Yes all CPF
2 3.5. Number and levels of team roles	Can these be varied?	Yes
2.4. Ability to run pre-packaged scenario to a defined timeline	Certain events at certain points on time line, regardless of player response. Data to be collected on that time line.	Yes
2.5. Ability to control select variables in real time	Ad hoc failures of Circuit or Net, workstation to fail, wpn system to fail.	Yes
2.6. Ability to interject probes in real time	Freeze probes Tracking probes	Yes
2.7. Ability to stop/re-start scenarios		Yes
2 8. Ability to backup/re-run scenarios		Yes
2 9. Ability to dynamically modify scenario depending upon responses	If x then y e.g. if fails to respond to threat, re-insert same threat later If a then b	Yes, but would need to be continuous manual control
2 10. Comms among experimenters / controllers	Can observer / experimenter selectively provide instructions, ask questions over net to players or observers or controllers? If not can this be added?	Yes

3. Data Collection		
3.1. Ability to capture physical actions:		
3.1.1. Movement in OR	e.g video, movement sensors in OR or on person.	Yes
3.1.2. Workstation		
3.1.2.1. Keystrokes	Quad video, software based?	Yes
3.1.2.2. Screen navigation	Quad video, software bsed?	Yes
3.1.2.3. Comm buttons/pedals	On net, off net?	Yes
3.1.3 Other devices	Lap tops, PDAs, key pads, etc.	Yes
3 2 Ability to capture information exchange		
3 2.1. Written	Non CCS: formal (msg pad, format), informal (post it note, etc). Timing, content, source, addressee(s)	Yes –tied to video. If message, then would go into file. Informal exchanges – no, author would need to indicate position and time of message manually.
3 2.2. Verbal	Network vs non network Timing, content, source, addressee(s)	Yes

3.2.3. Visual	Face to face, stateboards, non CCS info sources (e.g. GCCS, plot, manuals, charts, etc) Timing, content, addressee(s) i.e. what is source of information.	Yes
3.3. Capability of recording contents of CCS Display	Time line, screen dump vs data content.	Screen saved in software
3.4 Ability to capture timing of actions and other events to required accuracy	Timeline resolution, registration to other workstations, etc.	Timeline – yes: -possibly 1 second- screen shows to 1/100.
3.5. Availability of observers as assessors.	Instructor SMEs to act as observers and interpreters for real time or post hoc review.	Yes- except during megaphase– depends on availability of local talent.
3.6. Ability to capture data in post analysis (by re-running scenario)	Can responses to scenario be re-run? How sophisticated, comprehensive is this capability? Can tempo and/or content be modified for each re-run. Can data sets be aggregated?	Yes High Yes: fast to 10x or slow motion to 1/4 No
3.7. Existence of training MOPs	Which OR positions? Doc available.	Yes

4. Data Storage and Analysis		
4.1. Ability to store data in a format that is readily exported for analysis	Can data be used in other analysis display software applications?	No
4.2. Ability to analyse data	Existing or on –site data analysis capabilities?	Yes, playback on site
4.3. Ability to display data	Existing or on –site data display capabilities?	Yes, playback on site
4.4. Reliable data storage	Types of reliability problems Crash risk Data formats Compatibility with	No standard data formats Little crash risk
4.5 Access to data after collection	Can data be taken off –site? Security issues?	No No

5. Availability of existing training MOPs		
5.1. Objective	Time and accuracy based metrics excluding rating scales	No
5.2. Subjective	Subjective instructor based (criteria, rating scales, etc).	Yes
5.3. Machine-based	Automatic implementation of objective measures above?	No

6. Environment and General Fidelity		
6.1. Interruption free	Unbroken sequences? Intrusive observers?	Yes
6.2. Appropriate illumination	Colour, level	Y –low white

6 3 Appropriate sound levels	Weapons, engine noise, talk	No
6.4. Appropriate Ship motion	Changes in direction, interference with movement, sickness?	No
6.5. Appropriate clothing	Is clothing representative (hoods, gloves, heat,)	Yes
6 6. Layout appropriate to OR (where required)	Lines of sight to stateboards, space for notes, etc.	Yes
6.7. Range of tasks	Can all tasks be simulated? What tasks cannot?	Yes
6.8. Tempo of operations	Same pace as operations?	Yes
6.9. Communication	e g. volume and type of text messages, responsiveness, sound, level of radio comms, etc.	Lower volume of text messages – lower level of voice comm than in real TG
6.10 Complexity	e g. multi-tasking	Yes. At ORO level no Damcat, logistics for injured personnel
6.11. Workload	Is workload representative	Yes– see above
6 12 Duration	Sustained operations, time of day, fatigue	Yes – more easily done on ship, but typical scenarios are less than 4hrs
6 13 Manning levels	Realistic for operation	No CSE – no . no extra personnel for action stations
6.14. Threat levels	Are they realistic?	Yes
6.15. Force configuration and role.	Enemy and friendly.	Yes
6 16 Stress	Type, intensity	Yes
6.17. Mission (s)	e.g OOTW players. Multi-national, Aid to civil power.	Can be done
6.18. Social dimensions	Use of intact teams?	Yes
6.19. Other	Quals / experience of participants? knowledge of mission prior to start scenario.	None experienced Y

C.2 NCOT

1. Logistics NCOT		
1.1. Availability of facility	Booking process (advance notice etc) Program (annual?) Sharing vs exclusive Duration of booking 24/7, etc.	Same as ORTT Currently more available than ORTT Must be shared with MD in the short term
1.2. Set up time for facility	How much work / time to prepare from current status.	Less than 1 day
1.3. Number of CCS workstations	All linked?	38 WS in two classrooms/all linked.
1.4. OR Team simulated	OP/SUP/WD/ORO/CO Specialities (EW/SONAR/ETC) Outside sources (bride, helo, etc)	All+CANEWS; no bridge WS but can provide info from bridge and helo
1.5. Suitable system docs & manuals available?	Availability: what, where, removable? Suitability: Contents, Set up vs maintenance.	CD – both operating and maintenance
1.6. Availability of Technical/Controller support for		
1.6.1. Software/hardware during preparation	Help with set up of equipment Scenario development and set up Set data capture equipment, software, analysis	Yes through arrangements with MD. Possibility of training T&E staff in procedures.
1.6.2. Software/hardware during testing	Maintenance / repair of crashes Ad hoc changes to scenario (Unplanned insertion of data)	Yes - but limited. No available Navy infrastructure at present for game players.
1.6.3. Control scenario play	Availability of controller staff as scenario players, war game directors?	No specifically assigned Navy staff for this responsibility.
1.6.4. Software/hardware during analysis	Data capture and analysis, downloading, configuring for other analysis software, etc.	No, but could be developed by MD
1.6.5. Trg of HSI® test personnel in technical issues	How are HSI®™ staff to be trained	Yes, on site
1.7. Availability of Personnel as test participants		TBD
1.7.1. Number	How many can we get?	
1.7 2. Expenence / qualifications	What range of experience and qualification (e.g. students only?)	
1.7.3. Individuals or teams	Will they have worked together before?	
1.7.4. Notice required	How far ahead is booking required?	
1.7.5. Range of OR team represented	Different availability for different levels? Are "filler" personnel available for part task simulation?	
1.8. Video recording available		

1.8 1. Type of video	# workstations covered, duration of recording, Time coord with different video / audio /other sources. Wide area coverage Macro coverage / resolution of CCS screen data Quad coverage Tracking (pan, zoom, etc) Low light / red light	No, could be added as independent recorder No, manual
1 8.2. Eye tracking capability	Video, other	Same as ORTT
1.9. Audio recording available		
1.9.1. Type of audio	# workstations covered (internal vs external to OR), duration of recording, Time coord with different video / audio /other sources. identification of position(s), incoming vs outgoing audio quality (noise, etc) off net speech in OR	Yes, linked to scenario Good (on the word of the MD rep) Need extra audio recording – not co-ordinated
1.10. Information exchange (is it represented?		No external sim room for providing this capability
1.10 1 Internal net in OR	Who can be on it in trainer?	Yes
1.10.2. External nets to OR on ship	Who can be on it trainer?	Yes
1.10 3. External nets to ship	Who can be on it trainer?	Yes
1.10 4. Text	What types of text messages? Level of text message activity?	Yes Satisfactory
1.10.5. Face to face in OR	Direct voice contact in OR?	Yes, would need separate audio
1 10 6. Other information exchanges	State boards Manuals / Charts / Tacpacs / Post its / etc.	No, could be added No, could be added
1.11 Customise environment for data collection	Ability to add COMDAT prototype equipment / software Technical support for this?	No, except as simulated and programmed by MDA
1.11.1. Extra audio and video	Add extra audio / video data capture devices	Yes
1.11.2. Add on software modules	Ability to add on software modules to interject data into canned scenarios/simulations	Yes
1.12. Standalone keypads, notebooks or PDA's for data entry by participants or observers?	Eg for workload ratings at intervals Or for response to freeze probes or for diary entry	Yes
1.13. Reliability of system	Types of reliability problems Crash risk Repair time / typical down time Repeatability of scenarios	Unknown
1.14. Space for observers	Is there space for more people to observe / capture data. Worst case = one observer at each work station.	Yes

2. Experimental control		
2.1. Environmental control (lighting, acoustics, thermal, motion)	Adjustability and control over lighting Adjustability and control over acoustics	Lighting variable No
2.2. Pre-packaged scenario	Availability? Modifiability? (e.g. freeze and tracking probes)	Yes Yes
2.3. Complexity of scenarios		
2.3.1. Mission types	Location, threat type, TG configuration, OOTW, Aid civil power, etc	Any
2.3.2. Mission segments	Part task breakdown capability	Yes
2.3.3. Number of players	Multiple players on single task, or single player multiple roles.	Both – very flexible groupings of controllers and players
2.3.4. Number and types of assets	How many and what types en / fr / neutral ships, a/c, wpns, sensors, etc. Can these be varied?	No limit Yes
2.3.5. Number and levels of team roles	Can these be varied?	Yes
2.4. Ability to run pre-packaged scenario to a defined timeline	Certain events at certain points on time line, regardless of player response. Data to be collected on that time line.	Yes Yes, more could be programmed
2.5. Ability to control select variables in real time	Ad hoc failures of Circuit or Net, workstation to fail, wpn system to fail.	Yes
2.6. Ability to interject probes in real time	Freeze probes Tracking probes	Yes Yes
2.7. Ability to stop/re-start scenarios		Yes
2.8. Ability to backup/re-run scenarios		No
2.9. Ability to dynamically modify scenario depending upon responses	If x then y e.g. if fails to respond to threat, re-insert same threat later If a then b	Yes, through controller
2.10. Comms among experimenters / controllers	Can observer / expr provide instructions, ask questions over net to players or observers or controllers? If not can this be added?	Yes

3. Data Collection		
3.1. Ability to capture physical actions:		
3.1.1. Movement in OR	e.g video, movement sensors in OR or on person.	Yes, but extra video required
3.1.2. Workstation		

3.1.2.1. *Keystrokes*	Quad video, software based?	Yes - software
3.1.2.2. *Screen navigation*	Quad video, software bsed?	Yes- software
3.1.2.3. *Comm buttons/pedals*	On net, off net?	Yes- software
3.1 3. Other devices	Lap tops, PDAs, key pads, etc.	Yes, not co-ordinated
3.2. Ability to capture information exchange		
3.2.1. Wntten	Non CCS: formal (msg pad, format), informal (post it note, etc). Timing, content, source, addressee(s)	Yes
3.2.2. Verbal	Network vs non network Timing, content, source, addressee(s)	Yes, need extra recorder for non-network
3.2.3. Visual	Face to face, stateboards, non CCS info sources (e.g. GCCS, plot, manuals, charts, etc) Timing, content, addressee(s) i.e. what is source of information.	Yes, need extra recorder for non-network
3 3. Capability of recording contents of CCS Display	Time line, screen dump vs data content.	Yes to all
3.4. Ability to capture timing of actions and other events to required accuracy	Timeline resolution, registration to other workstations, etc.	Less < sec
3.5. Availability of observers as assessors.	Instructor SMEs to act as observers and interpreters for real time or post hoc review.	Same as ORTT
3.6. Ability to capture data in post analysis (by re-running scenario)	Can responses to scenario be re-run? How sophisticated, comprehensive is this capability? Can tempo and/or content be modified for each re-run. Can data sets be aggregated?	Yes Very Content yes, tempo no. No, would require special software
3.7. Existence of training MOPs	Which OR positions? Doc available.	See ORTT

4. Data Storage and Analysis		
4.1. Ability to store data in a format that is readily exported for analysis	Can data be used in other analysis display software applications?	No, would require extra software
4.2. Ability to analyse data	Existing or on –site data analysis capabilities?	Yes, manual analysis, MD could develop required software
4.3. Ability to display data	Existing or on –site data display capabilities?	Yes
4.4. Reliable data storage	Types of reliability problems Crash risk Data formats Compatibility with	Yes No
4.5 Access to data after collection	Can data be taken off –site? Security issues?	No,– would need special arrangements and local playback capability. No different from ORTT, CSTC – commercial proprietary issues

5. Availability of existing training MOPs		
5.1. Objective	Time and accuracy based metrics excluding rating scales	
5.2. Subjective	Subjective instructor based (criteria, rating scales, etc).	
5.3. Machine-based	Automatic implementation of objective measures above?	

6. Environment and General Fidelity		
6.1. Interruption free	Unbroken sequences? Intrusive observers?	Yes. Yes; no remote observation right now but could be added
6.2. Appropriate illumination	Colour, level	Room lighting - not variable
6.3. Appropriate sound levels	Weapons, engine noise, talk	No – except for talk
6.4. Appropriate Ship motion	Changes in direction, interference with movement, sickness?	No
6.5 Appropriate clothing	Is clothing representative (hoods, gloves, heat,)	Could be
6 6. Layout appropriate to OR (where required)	Lines of sight to stateboards, space for notes, etc.	No, but could be adapted
6 7. Range of tasks	Can all tasks be simulated? What tasks cannot?	Yes, except GMCS
6.8. Tempo of operations	Same pace as operations?	Could be
6.9. Communication	e.g. volume and type of text messages, responsiveness, sound, level of radio comms, etc.	Yes, depends on configuration, but generally less
6.10. Complexity	e.g. multi-tasking	Less than OR
6.11. Workload	Is workload representative	Depends on position – probably acceptable at the Operator level, unknown and possibly doubtful at the command level
6.12. Duration	Sustained operations, time of day, fatigue.	Possible - limited by 2GB of data storage
6.13. Manning levels	Realistic for operation	No
6.14. Threat levels	Are they realistic?	Yes
6.15 Force configuration and role.	Enemy and friendly.	Yes
6.16. Stress	Type, intensity.	No
6.17. Mission (s)	e.g. OOTW players. Multi-national, Aid to civil power.	Yes, any possible
6.18. Social dimensions	Use of intact teams?	Yes
6.19. Other	Quals / experience of participants? Background knowledge of mission prior to start scenario.	Same as ORTT –depends on choice and availability.

C3. CSTC

Logistics		
1.1. Availability of facility	Booking process (advance notice etc) Program (annual?) Sharing vs exclusive Duration of booking 24/7, etc.	Same as ORTT More available: shifts of 8 hours,24/7 operation. LM 8hrs, CFNOS 8 hrs Very little available capacity. Booking procedure same as ORTT.
1.2. Set up time for facility	How much work / time to prepare from current status.	One hour
1.3. Number of CCS workstations	All linked?	11 linked plus out-stations in OR
1 4. OR Team simulated	OP/SUP/WD/ORO/CO Specialities (EW/SONAR/ETC) Outside sources (bridge, helo, etc)	All plus CANEWS, HMS, SPS; no Tail, no GMCS.
1.5. Suitable system docs & manuals available?	Availability· what, where, removable? Suitability: Contents, Set up vs maintenance.	Y: no user manual-could be on disk.
1.6. Availability of Technical/Controller support for		
1.6.1. Software/hardware during preparation	Help with set up of equipment Scenario development and set up Set data capture equipment, software, analysis	Yes
1 6 2. Software/hardware during testing	Maintenance / repair of crashes Ad hoc changes to scenario (Unplanned insertion of data)	Yes
1 6.3. Control scenario play	Availability of controller staff as scenario players, war game directors?	Yes
1 6.4 Software/hardware during analysis	Data capture and analysis, downloading, configuring for other analysis software, etc.	Limited: recording. Can only playback in CSTC; No time tags, have to remember time of events. There is a trade-off between amount of information recorded and playback time, could be as little as 10 mins for everything.
1.6.5. Trg of HSI® test personnel in technical issues	How are HSI®™ staff to be trained	Yes, easier than ORTT.
1.7. Availability of Personnel as test participants		
1.7 1. Number	How many can we get?	
1.7.2. Experience / qualifications	What range of experience and qualification (e.g. students only?)	
1.7.3 Individuals or teams	Will they have worked together before?	
1.7.4. Notice required	How far ahead is booking required?	
1.7.5. Range of OR team represented	Different availability for different levels? Are "filler" personnel available for part task simulation?	
1.8. Video recording available		

1.8.1. Type of video	# workstations covered, duration of recording, Time coord with different video / audio /other sources. Wide area coverage Macro coverage / resolution of CCS screen data Quad coverage Tracking (pan, zoom, etc) Low light / red light	None – but could be added eg C-SAVRAS
1.8.2. Eye tracking capability	Video, other	No
1.9. Audio recording available		
1.9.1. Type of audio	# workstations covered (internal vs external to OR), duration of recording, Time coord with different video / audio /other sources. identification of position(s), incoming vs outgoing audio quality (noise, etc) off net speech in OR	No, but the capability is there. Passive audio tape could be implemented but would not be co-ordinated with software data capture. C-SAVRAS may also be plugged into any 6 ws. Off-network audio would require manual recording. Quality good
1.10. Information exchange (is it represented?		
1.10.1. Internal net in OR	Who can be on it in trainer?	Yes plus PRC walkie talkie. All inputs are put in real time, cannot be pre-programmed
1.10.2. External nets to OR on ship	Who can be on it trainer?	Yes
1 10.3. External nets to ship	Who can be on it trainer?	Yes
1.10.4. Text	What types of text messages? Level of text message activity?	Yes, but manually handled
1.10.5. Face to face in OR	Direct voice contact in OR?	Yes
1.10.6. Other information exchanges	State boards Manuals / Charts / Tacpacs / Post its / etc.	Yes Yes
1.11. Customise environment for data collection	Ability to add COMDAT prototype equipment / software Technical support for this?	Yes-if configured for ship, then would fit CSTC. Yes
1.11.1. Extra audio and video	Add extra audio / video data capture devices	Yes
1.11.2. Add on software modules	Ability to add on software modules to interject data into canned scenarios/simulations	No- this would need to be done manually
1.12. Standalone keypads, notebooks or PDA's for data entry by participants or observers?	Eg for workload ratings at intervals Or for response to freeze probes or for diary entry	Yes
1.13. Reliability of system	Types of reliability problems Repair time / typical down time Repeatability of scenarios	90%+ Hour High
1.14. Space for observers	Is there space for more people to observe / capture data. Worst case = one observer at each workstation.	Yes

2. Experimental control		
2.1. Environmental control (lighting, acoustics, thermal, motion)	Adjustability and control over lighting Adjustability and control over acoustics	Yes Normal – but also background noise from AC – no simulated systems noise (eg. Weapons)
2.2. Pre-packaged scenario	Availability? Modifiability? (e g. freeze and tracking probes)	Yes-manual input of all sim events and comms Y
2.3. Complexity of scenarios		
2.3.1. Mission types	Location, threat type, TG configuration, OOTW, Aid civil power, etc	Same as OTTC
2.3.2. Mission segments	Part task breakdown capability	Yes
2.3.3. Number of players	Multiple players on single task, or single player multiple roles.	No multiple players for a single position, but – 3 possible for any back row position.
2.3.4. Number and types of assets	How many and what types en / fr / neutral ships, a/c, wpns, sensors, etc. Can these be varied?	Yes
2 3.5. Number and levels of team roles	Can these be varied?	Yes
2.4. Ability to run pre-packaged scenario to a defined timeline	Certain events at certain points on time line, regardless of player response. Data to be collected on that time line.	Yes, but manual sim input required Yes
2.5. Ability to control select variables in real time	Ad hoc failures of Circuit or Net, workstation to fail, wpn system to fail.	Yes
2.6. Ability to interject probes in real time	Freeze probes Tracking probes	Yes Yes
2.7. Ability to stop/re-start scenarios		Yes
2.8. Ability to backup/re-run scenarios		Yes, requires manual control
2.9. Ability to dynamically modify scenario depending upon responses	If x then y e.g. if fails to respond to threat, re-insert same threat later If a then b	Yes
2.10. Comms among experimenters / controllers	Can observer / exper provide instructions, ask questions over net to players or observers or controllers? If not can this be added?	Yes

3. Data Collection		
3.1. Ability to capture physical actions:		
3.1 1. Movement in OR	e.g video, movement sensors in OR or on person.	None – camera could be added, this would be on a separate time base

3.1.2. Workstation		
3.1.2.1. Keystrokes	Quad video, software based?	N, but C-SAVRAS could be added.
3.1.2.2. Screen navigation	Quad video, software bsed?	Yes
3.1.2.3. Comm buttons/pedals	On net, off net?	Yes – tied with video
3.1.3. Other devices	Lap tops, PDAs, key pads, etc.	Yes
3.2. Ability to capture information exchange		
3.2.1. Written	Non CCS: formal (msg pad, format), informal (post it note, etc). Timing, content, source, addressee(s)	Yes –same as ORTT
3.2.2. Verbal	Network vs non network Timing, content, source, addressee(s)	No – unless on intercom and C-SAVRAS is in place
3.2.3. Visual	Face to face, stateboards, non CCS info sources (e.g. GCCS, plot, manuals, charts, etc) Timing, content, addressee(s) i.e. what is source of information.	Yes – need separate video
3.3. Capability of recording contents of CCS Display	Time line, screen dump vs data content.	No, only through C-SAVRAS
3 4. Ability to capture timing of actions and other events to required accuracy	Timeline resolution, registration to other workstations, etc.	Yes, no time delay – 1 sec resolution
3 5. Availability of observers as assessors.	Instructor SMEs to act as observers and interpreters for real time or post hoc review.	Yes – as for ORTT
3.6. Ability to capture data in post analysis (by re-running scenario)	Can responses to scenario be re-run? How comprehensive is this capability? Can tempo and/or content be modified for each re-run. Can data sets be aggregated?	No – but limited workstations with limited data. Takes more work Yes for CCS data No
3 7. Existence of training MOPs	Which OR positions? Doc available.	Yes

4. Data Storage and Analysis		
4.1. Ability to store data in a format that is readily exported for analysis	Can data be used in other analysis display software applications?	No would need special software to convert (see comments on History recording under C-SAVRAS.
4 2. Ability to analyse data	Existing or on –site data analysis capabilities?	Yes
4.3. Ability to display data	Existing or on –site data display capabilities?	Yes
4.4. Reliable data storage	Types of reliability problems Crash risk Data formats Compatibility with	High – relies on experienced operator
4.5. Access to data after collection	Can data be taken off –site? Security issues?	Yes, at warfare centre No, for exercise data

5. Availability of existing training MOPs		
5.1. Objective	Time and accuracy based metrics excluding rating scales	
5.2. Subjective	Subjective instructor based (criteria, rating scales, etc).	
5.3. Machine-based	Automatic implementation of objective measures above?	

6. Environment and General Fidelity		
6.1. Interruption free	Unbroken sequences? Intrusive observers?	Yes, up to sustained ops
6.2. Appropriate illumination	Colour, level	Yes same as Ops room
6 3. Appropriate sound levels	Weapons, engine noise, talk	No, but A/C noise present
6 4 Appropriate Ship motion	Changes in direction, interference with movement, sickness?	No
6 5 Appropriate clothing	Is clothing representative (hoods, gloves, heat,)	Yes
6.6. Layout appropriate to OR (where required)	Lines of sight to stateboards, space for notes, etc.	Yes
6.7. Range of tasks	Can all tasks be simulated? What tasks cannot?	Yes
6.8. Tempo of operations	Same pace as operations?	Yes
6.9. Communication	e.g. volume and type of text messages, responsiveness, sound, level of radio comms, etc.	Yes
6.10. Complexity	e.g. multi-tasking	Yes
6.11. Workload	Is workload representative	Yes
6.12. Duration	Sustained operations, time of day, fatigue.	Better than ORTT - could run for a shift or more
6.13. Manning levels	Realistic for operation	Yes
6.14. Threat levels	Are they realistic?	Yes
6.15. Force configuration and role.	Enemy and friendly.	Yes
6.16. Stress	Type, intensity.	Same as ORTT
6.17. Mission (s)	e.g OOTW players. Multi-national, Aid to civil power.	Same as ORTT: Y
6.18. Social dimensions	Use of intact teams?	Yes
6.19. Other	Quals / experience of participants? Background knowledge of mission prior to start scenario.	Same as ORTT.

C4. Ops Room (Harbourside/at sea)

1. Logistics		
1.1. Availability of facility	Booking process (advance notice etc) Program (annual?) Sharing vs exclusive Duration of booking 24/7, etc.	Highly dependent upon ship availability, which is unknown at present. But when refit in progress there may be extended opportunities to access and us OR. Booking procedure unknown. Current programming unklnown.
1.2. Set up time for facility	How much work / time to prepare from current status.	One hour
1.3. Number of CCS workstations	All linked?	All positions linked as in normal Ops.
1 4. OR Team simulated	OP/SUP/WD/ORO/CO Specialties (EW/SONAR/ETC) Outside sources (bridge, helo, etc)	All plus CANEWS, HMS, SPS; including GMCS and CANTASS
1.5. Suitable system docs & manuals available?	Availability: what, where, removable? Suitability: Contents, Set up vs maintenance.	Y: no user manual-could be on disk.
1.6. Availability of Technical/Controller support for		
1 6.1. Software/hardware during preparation	Help with set up of equipment Scenario development and set up Set data capture equipment, software, analysis	Yes
1.6.2. Software/hardware during testing	Maintenance / repair of crashes Ad hoc changes to scenario (Unplanned insertion of data)	Yes
1 6.3. Control scenario play	Availability of controller staff as scenario players, war game directors?	Yes
1 6.4. Software/hardware during analysis	Data capture and analysis, downloading, configuring for other analysis software, etc.	Limited: recording. Can only playback in CSTC or Ops Room; No time tags, have to remember time of events. There is a trade-off between amount of information recorded and playback time, could be as little as 10 mins for everything.
1.6.5. Trg of HSI® test personnel in technical issues	How are HSI®™ staff to be trained	Yes, easier than ORTT.
1.7. Availability of Personnel as test participants		
1.7.1. Number	How many can we get?	
1.7.2. Experience / qualifications	What range of experience and qualification (e.g. students only?)	
1.7.3. Individuals or teams	Will they have worked together before?	
1.7.4. Notice required	How far ahead is booking required?	
1.7.5. Range of OR team represented	Different availability for different levels? Are "filler" personnel available for part task simulation?	
1.8. Video recording available		

1 8.1. Type of video	# workstations covered, duration of recording, Time coord with different video / audio /other sources. Wide area coverage Macro coverage / resolution of CCS screen data Quad coverage Tracking (pan, zoom, etc) Low light / red light	None – but could be added eg C-SAVRAS
1.8.2. Eye tracking capability	Video, other	No
1.9. Audio recording available		
1.9.1. Type of audio	# workstations covered (internal vs external to OR), duration of recording, Time coord with different video / audio /other sources. identification of position(s), incoming vs outgoing audio quality (noise, etc) off net speech in OR	No, but the capability is there. Passive audio tape could be implemented but would not be co-ordinated with software data capture. C-SAVRAS may also be plugged into any 6 ws. Off-network audio would require manual recording. Quality good
1.10. Information exchange (is it represented?		
1 10 1 Internal net in OR	Who can be on it in trainer?	Yes, all inputs are put in real time, cannot be pre-programmed
1.10.2. External nets to OR on ship	Who can be on it trainer?	Yes
1.10.3. External nets to ship	Who can be on it trainer?	Yes
1.10.4. Text	What types of text messages? Level of text message activity?	Yes, but manually handled
1.10.5. Face to face in OR	Direct voice contact in OR?	Yes
1.10.6. Other information exchanges	State boards Manuals / Charts / Tacpacs / Post its / etc.	Yes Yes
1 11. Customise environment for data collection	Ability to add COMDAT prototype equipment / software Technical support for this?	Yes. Yes
1.11.1. Extra audio and video	Add extra audio / video data capture devices	Yes
1.11.2. Add on software modules	Ability to add on software modules to interject data into canned scenarios/simulations	No- this would need to be done manually
1.12. Standalone keypads, notebooks or PDA's for data entry by participants or observers?	Eg for workload ratings at intervals Or for response to freeze probes or for diary entry	Yes
1.13. Reliability of system	Types of reliability problems Repair time / typical down time Repeatability of scenarios	90%+ Hour High
1.14. Space for observers	Is there space for more people to observe / capture data. Worst case = one observer at each work station.	Yes

2. Experimental control		
2.1. Environmental control (lighting, acoustics, thermal, motion)	Adjustability and control over lighting Adjustability and control over acoustics	NA NA
2.2. Pre-packaged scenario	Availability? Modifiability? (e.g. freeze and tracking probes)	Yes-manual input of all sim events and comms Y
2.3. Complexity of scenarios		
2.3.1. Mission types	Location, threat type, TG configuration, OOTW, Aid civil power, etc	Same as OTTC
2.3.2. Mission segments	Part task breakdown capability	Yes
2.3.3. Number of players	Multiple players on single task, or single player multiple roles.	No multiple players for a single position, but – 3 possible for any back row position.
2.3.4. Number and types of assets	How many and what types en / fr / neutral ships, a/c, wpns, sensors, etc. Can these be varied?	Yes
2.3.5. Number and levels of team roles	Can these be varied?	Yes
2.4. Ability to run pre-packaged scenario to a defined timeline	Certain events at certain points on time line, regardless of player response. Data to be collected on that time line.	Yes, but manual sim input required Yes
2.5 Ability to control select variables in real time	Ad hoc failures of Circuit or Net, workstation to fail, wpn system to fail.	Yes
2.6. Ability to interject probes in real time	Freeze probes Tracking probes	Yes Yes
2.7. Ability to stop/re-start scenarios		Yes
2.8. Ability to backup/re-run scenarios		Yes, requires manual control
2.9. Ability to dynamically modify scenario depending upon responses	If x then y e.g. if fails to respond to threat, re-insert same threat later If a then b	Yes
2.10. Comms among experimenters / controllers	Can observer / expr provide instructions, ask questions over net to players or observers or controllers? If not can this be added?	Yes

3. Data Collection		
3.1. Ability to capture physical actions:		
3.1.1. Movement in OR	e g video, movement sensors in OR or on person	None – camera could be added, this would be on a separate time base

3.1.2. Workstation		
3.1.2.1. Keystrokes	Quad video, software based?	N, but C-SAVRAS could be added.
3.1.2.2. Screen navigation	Quad video, software bsed?	Yes
3.1.2.3. Comm buttons/pedals	On net, off net?	Yes – tied with video
3.1.3. Other devices	Lap tops, PDAs, key pads, etc.	Yes
3.2. Ability to capture information exchange		
3.2.1. Written	Non CCS: formal (msg pad, format), informal (post it note, etc). Timing, content, source, addressee(s)	Yes
3.2.2. Verbal	Network vs non network Timing, content, source, addressee(s)	No – unless on intercom and C-SAVRAS is in place
3 2 3. Visual	Face to face, stateboards, non CCS info sources (e.g. GCCS, plot, manuals, charts, etc) Timing, content, addressee(s) i.e. what is source of information.	Yes – need separate video
3.3. Capability of recording contents of CCS Display	Time line, screen dump vs data content.	No, only through C-SAVRAS
3 4 Ability to capture timing of actions and other events to required accuracy	Timeline resolution, registration to other workstations, etc.	Yes, no time delay – 1 sec resolution
3.5. Availability of observers as assessors.	Instructor SMEs to act as observers and interpreters for real time or post hoc review.	Yes – as for ORTT and CSTC
3.6. Ability to capture data in post analysis (by re-running scenario)	Can responses to scenario be re-run? How sophisticated is this capability? Can tempo and/or content be modified for each re-run. Can data sets be aggregated?	No – but limited workstations with limited data. Takes more work Yes for CCS data No
3.7. Existence of training MOPs	Which OR positions? Doc available.	Yes

4. Data Storage and Analysis		
4 1. Ability to store data in a format that is readily exported for analysis	Can data be used in other analysis display software applications?	No would need special software to convert (see comments on History recording under C-SAVRAS.
4.2. Ability to analyse data	Existing or on –site data analysis capabilities?	Yes
4.3. Ability to display data	Existing or on –site data display capabilities?	Yes
4.4. Reliable data storage	Types of reliability problems Crash risk Data formats Compatibility with	High – relies on experienced operator Compatible with Excel using existing software conversion of specific data elements.
4.5. Access to data after collection	Can data be taken off –site? Security issues?	Yes, at warfare centre No, for exercise data

5. Availability of existing training MOPs		
5 1. Objective	Time and accuracy based metrics excluding rating scales	
5.2. Subjective	Subjective instructor based (criteria, rating scales, etc).	
5.3. Machine-based	Automatic implementation of objective measures above?	

6. Environment and General Fidelity		
6.1. Interruption free	Unbroken sequences? Intrusive observers?	Yes, up to sustained ops
6.2. Appropriate illumination	Colour, level	NA
6.3. Appropriate sound levels	Weapons, engine noise, talk	NA
6.4. Appropnate Ship motion	Changes in direction, interference with movement, sickness?	No
6.5. Appropriate clothing	Is clothing representative (hoods, gloves, heat,)	Yes
6.6. Layout appropriate to OR (where required)	Lines of sight to stateboards, space for notes, etc.	Yes
6.7. Range of tasks	Can all tasks be simulated? What tasks cannot?	Yes
6.8. Tempo of operations	Same pace as operations?	Yes
6.9. Communication	e.g. volume and type of text messages, responsiveness, sound, level of radio comms, etc.	Yes
6.10. Complexity	e.g. multi-tasking	Yes
6.11. Workload	Is workload representative	Yes
6 12. Duration	Sustained operations, time of day, fatigue	Better than ORTT - could run for a shift or more
6 13 Manning levels	Realistic for operation	Yes
6.14. Threat levels	Are they realistic?	Yes
6.15. Force configuration and role.	Enemy and friendly.	Yes
6 16. Stress	Type, intensity.	Same as ORTT, CSTC
6.17. Mission (s)	e g. OOTW players. Multi-national, Aid to civil power.	Yes
6.18. Social dimensions	Use of intact teams?	Yes
6.19. Other	Quals / experience of participants? Background knowledge of mission prior to start scenario.	Same as ORTT.

Annex D: Glossary of Technical Terms and Common Abbreviations

AAW	Anti-Air Warfare
ASUW	Anti-Surface Warfare
AOP	Area of Probability
ASW	Anti-Submarine Warfare
ASWC	Assistant Sensor Weapons Controller, also Anti-submarine Warfare Commander
AWSS	Acoustic Warfare Support Specialist
CANEWS	Canadian Electronic Warfare System
CANTASS	Canadian Towed Array Sonar System
C2	Command and Control
CCS	Command and Control System
CMOG 1	Commander Maritime Operations Group One
CO	Commanding Officer
CPF	Canadian Patrol Frigate
C-SAVRAS	Combat System Audio Visual Recording and Analysis System
CSTC	Combat Systems Training Centre
CIWS	Close In Weapon System
DCIEM	Defence and Civil Institute for Environmental Medicine
DREV	Defence Research Establishment Valcartier
ESM	Electronic Support Measures
EW	Electronic Warfare
EWS	Electronic Warfare Supervisor
EWSS	EW Support Specialist
FCS	Fire Control Supervisor
GCCS	Global Command and Control System
GO(s)	Gamepiece Operators (s)
HMS	Hull-Mounted Sonar
HR	History Record
HSI	Human*systems* Incorporated
IS	Instructor Station
L-M	Lockheed-Martin
MD	McDonald Dettweiler

MOP(s)	Measure(s) of Performance
MOG 1	Maritime Operations Group One
MPA	Maritime Patrol Aircraft
MSDF	Multi-Sensor Data Fusion
NAV COMMS	Naval Communicators
NCM	Non-Commissioned Member
NCOT	Naval Combat Operator Trainer
OCS	Officer Conducting the Serial
OMI	Operator Machine Interface
OOW	Officer of the Watch
Ops Room	HALIFAX Class Operations Room
ORO	Operations Room Officer
ORS	Operations Room Supervisor
ORTT	Operations Room Team Trainer
OSS	Ownship Support Specialist
QAB	Quick-Action Button
RCP	Remote Control Panel
RT (1,2)	Radar Tracker (1 and 2)
RAMSES	Reprogrammable Advanced Multimode Shipboard ECM System
SAC	Shipboard Air Controller
SASIE	System Analysis Simulation Evaluation
SATCOM	Satellite Communications
SCS	Sonar Control Supervisor
SHINCOM	Shipboard Integrated Communications System
SigOp	Signals Operator
SimOps	Simulated Operations Room
SPS	Sonobuoy Processing System
STIRs	Separate Tracking and Illuminating Radars
SWC	Sensor Weapons Controller (also Surface Warfare Commander)
SME(s)	Subject Matter Expert(s)
TAC AAW	Anti-Air Warfare Tactical Instructor
TAC AsuW	Anti-Surface Warfare Tactical Instructor
TAC ASW	Anti-Submarine Warfare Tactical Instructor
TAC CCIS	Tactical Command, Command and Control Information System Instructor

TCO	Trainer Control Officer
TCS	Trainer Control Supervisor
TS	Track Supervisor
T&E	Test and Evaluation
TTTO	Tactics and Team Training Officer
WCP	Weapons Control Panel
XBT	Expendable Bathythermograph
XSV	Expendable Sound Velocimeter

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14. ABSTRACT

(U) This report reviews five training simulator facilities in the Canadian Navy for their suitability in conducting test and evaluation (T&E) in support of the COMDAT multi-sensor data fusion (MSDF) initiative. The facilities are the Operations Room Team Trainer (ORTT), the Naval Combat Operator Trainer (NCOT), the Combat Systems Training Centre (CSTC) and HALIFAX Class Ops Room at harbourside or at sea. A set of detailed capabilities for conducting T&E was developed under the four major categories of : Logistics, Experimental Control, Data Collection and Data Storage and Analysis. Each of the potential facilities was reviewed against these categories and the capabilities of each facility were then assessed for their suitability for conducting the expected range of T&E activities. It was concluded that the NCOT would be the most suitable facility for conducting T&E using single operators and small teams performing simple operational functions such as detecting and tracking radar contacts. For more complex functions in the Ops Room, including tasks involving interactions between complete warfare teams, interactions between warfare directors and the ORO, and between the ORO, CO and the entire Ops Room team, the ORTT represents the appropriate environment for conducting T&E activities. A range of scenarios exists for the ORTT and for NCOT, which may be adaptable for T&E purposes. Severe constraints on the availability of the ORTT (and possibly the NCOT) and the associated personnel infrastructure were noted, due to existing training demand for the Navy. It is recommended that a simple proof of concept trial for assessing the suitability NCOT for T&E be conducted as soon as possible.

15. KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U)